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RESEARCH AND INDUSTRIAL EFFICIENCY

THE recent debate on economic policy in the House of Commons laid a good deal of stress on the increase of industrial efficiency as a factor in a policy for full employment and the reconstruction of world trade. Sir Kingsley Wood's remarks on industrial development and research were highly significant and follow appropriately on the appointment by the Federation of British Industries of a committee under Sir William Larke to consider industrial research problems.

We must, said the Chancellor, "regain our technical leadership and pay more and more attention to training and scientific research, and go on steadily developing new and more efficient processes. War in all industrial countries releases a high potential of invention and development over a much shorter period than would ordinarily occur." The Chancellor referred in particular to such important changes at work as the chemistry of oil, the development of plastics, the increasing use of light alloys and new processing for foodstuffs.

Sir Kingsley Wood said rightly that the industrial skill and experience of Great Britain will be wasted unless we turn ourselves willingly to the new products. This is the real meaning of the mobility or fluidity of labour, of capital and of management. The importance of scientific research was repeatedly stressed in this debate. It is against this background that the significance of Lord Nuffield's latest endowment, the Nuffield Foundation, which includes as one of its objects the assistance of scientific research and teaching in the interests of trade and learning, should be assessed ; and there could scarcely be a better aid to such appreciation than the Atkinson Memorial Lecture on "Industrial Research in Great Britain : A Policy for the Future", which Dr. P. Dunsheath delivered before the Royal Society of Arts on February 1. This lecture followed aptly on the attention which had previously been directed to the subject at the Conference of the Association of Scientific Workers the previous week-end, an interest which was also reflected in Sir John Anderson's speech at the luncheon of the Parliamentary and Scientific Committee on February 11, and in that of Mr. Herbert Morrison on export trade at Nottingham on February 13.

Dr. Dunsheath emphasized at the start, independently of such considerations, the appropriateness of discussing at the present time the position of industrial research in Great Britain. First, experience gained during the latter part of the War of 1914–18 and immediately afterwards indicates that for the same expenditure of energy, greater progress can be made by taking advantage of the fluid state of science following a war than in normal times. Secondly, a wise extension of research could rectify, on the cessation of hostilities, certain artificial and temporary conditions in industry due to the War itself.

Dr. Dunsheath did not enter into the advantages

which follow the adoption of industrial research. Scientific research is now firmly established as one of the best long-term financial investments for an individual industrial concern and for a country as a whole. None the less, since the profits from this type of investment accrue to the industry rather than to those financially responsible, money for research is not always easy to find, and a principal consideration in post-war planning in Great Britain is to establish a public appreciation of the essential difference between this and other forms of investment.

Eschewing the thorny questions of the political form of government under which scientific research is likely to be most effective, Dr. Dunsheath emphasized the paramount importance in the immediate post-war reconstruction period of diverting war-time activities into peace-time channels with a minimum of social disorganization. The social implications of a generous extension of industrial research are of great concern, and though no fresh or reliable figures were quoted for comparison of the research effort of Great Britain with that of the United States or the U.S.S.R., there can be little doubt that the actual resources devoted to research must be increased if Great Britain is to remain in the forefront of industrial nations after the War. It cannot be said that it is yet on a scale worthy of our heritage of scientific achievement. The greatest contribution by far comes from the research laboratories of industry itself, and the magnitude of this is the most difficult to assess. The position and the attitude vary widely in different industries, and the Larke Committee will indeed render valuable service if it only succeeds in its proposal to survey present industrial research activities and obtain some indication of the results already achieved. The Committee is seeking information from research associations, commercial associations and individual firms, and it is to be hoped that the response will be such as to supply the comprehensive and authoritative figures which have been lacking in Great Britain. The importance of the inquiry well qualifies it for the interest and support of the Government, which Sir Kingsley Wood disclosed in his recent promise of fuller official statistics after the War.

Dr. Dunsheath's address was well calculated to dispel some misconceptions about a research department which still find currency, and he rightly said that a measure of the success of such a department is the extent to which it provides new knowledge and new principles for the use of departments more closely engaged in design and production. It is still necessary to prod industry to make it devote more attention to the provision of special staff and equipment for research, and at the same time to separate and make adequate provision for the scientific control of manufacture. Moreover, the separation of scientific from industrial research no longer holds. Industrial research laboratories cover the whole range of scientific research, from the most fundamental right up to the stage of technical application; indeed, in fields where expensive apparatus is required the equipment of the industrial laboratory may be far ahead of the academic.

The two major criticisms and suggestions which Dr. Dunsheath made of the present organization of industrial research are in regard to co-operation and to patents. Of the first, while co-operation in industry in different forms is growing, it is almost certain that a closer study of industrial statistics would indicate further opportunities for research; one of the fundamental problems is how to secure the sharing of knowledge between organizations which, by their closer contact with practical applications of science, both know the problems and are themselves advancing knowledge. One of the greatest services which could be rendered to industrial research to-day would be the provision of improved means for the cross-fertilization of ideas, and in urging closer contact between science and industry, Dr. Dunsheath showed himself fully aware of the vital factor which the universities represent in laying down future policy for industrial research.

Once again interchange of research staff was urged, as well as wider use of refresher courses, but Dr. Dunsheath's main suggestion is for improving the contact between Government departments such as the Service departments or the Department of Scientific and Industrial Research and industrial laboratories. He suggested that industrial research requires a central co-ordinating secretariat which would command respect in the industrial world and be in contact with a first-class scientific, technological and patent library. Such a body should maintain a comprehensive and accessible record of all researches in progress and completed, so as to bridge the gap between discovery and application and shorten the present long delay between the birth of knowledge and its availability for use. A valuable service would be the formulation of new problems and their allocation to suitable investigators.

It might be possible to house under the same roof some of the activities of some research associations, such as common rooms for meetings and more efficient means for the publication of reports. The unsatisfactory position in this respect is indicated by a recent letter on the organization of chemists (see NATURE, February 13, p. 191), in which a new federal body to deal, *inter alia*, with publications for the exchange and dissemination of chemical knowledge and with scientific meetings, is advocated if remodelling of the present Chemical Council is impracticable. Dr. Dunsheath suggested further that the present Patent Office with its library might well be a component part of the organization, which might be a public utility corporation of the type of the British Broadcasting Corporation. It would certainly be charged with the further task of securing public interest.

On the second major topic, Dr. Dunsheath directed attention to some of the well-known defects of the present patent law system of Great Britain in respect of industrial research, and especially the question of the freedom of application of new ideas. With regard to the system of blocking patents, by which it is possible, although contrary to the intention of the law, for the benefits of an improved design or process to be withheld from the public, Dr. Dunsheath pointed out

that to prevent an established industry being superseded, with accompanying loss, through obsolescence of plant, the practice is not necessarily reprehensible. The reasons may be sound, and too rapid a change may be wasteful; but the decision should not rest with the firm itself.

Dr. Dunsheath suggested that we require here some machinery for adjusting on a national basis the relative claims of the new invention as an improvement on existing ideas, and the established process or design which has probably reached the stage of mass production only after much expenditure of effort. Where, in the common interest, the new idea ought to be developed, it may be desirable to compensate the superseded industry with a fraction of the profits from the new one.

This question of patents is closely associated with the question of disclosure of activities before an investigation has reached a stage at which subject-matter for a patent can be formulated. Dr. Dunsheath pointed out that knowledge of the lines on which a research is being prosecuted can be of great value to a competitive interest. A mind coming fresh to a half-solved problem can sometimes take the final step to a successful conclusion more rapidly than the original investigator. This may well be an argument in favour of close co-operation from the general point of view, but the pre-patent stage is of vital importance in competitive industry; and it is clear that in dealing with this problem we must have some clear conception of the general structure of industry and the social and economic policy which is to be pursued.

The importance of protecting new ideas by secrecy or by patents is a factor in industrial research which must not be underrated, and it also cannot be considered without reference to such questions of general policy. Moreover, the large expenditure involved in development from discovery or invention to practical application can scarcely be forthcoming from private enterprise without adequate safeguards, if not from patent law then in an alternative way. Dr. Dunsheath made the further suggestion that one of the duties of the central co-ordinating body might be to secure secrecy at certain stages of an investigation in the interest of originating members, and to decide when, in the public interest, publication is desirable. He also suggested that this body might be granted the right to exact payment from industry for the use of non-patentable newly discovered scientific principles and to reinvest the proceeds in research—a suggestion which recalls the proposals for the protection of scientific property of which much was heard some ten or fifteen years ago. Finally, the same authority could be charged with the responsibility of granting licences to industrial concerns to operate only on condition that they made adequate contributions through their own laboratories, or otherwise, to the advancement of the science of the branch of industry concerned.

Dr. Dunsheath has, of course, entered on controversial matters in these latter suggestions, but his suggestions are further evidence that the patent system of Great Britain can operate in ways that are not entirely in the public interest or the best adapted to further scientific advance. His main suggestion for a co-ordinating authority, particularly in regard to records, is manifestly sound. Of the research association movement he said little by way of criticism; but the picture he gave of industrial research generally supports the view that a co-ordinating authority would have many functions to exercise beyond that of maintaining adequate and comprehensive records.

It is indeed abundantly clear that much yet remains to be done before we can be said to have in Great Britain a thoroughly well-organized structure of scientific and industrial research, which will adequately serve all the national needs. The attention which is now being focused on the restoration of export trade may well prove a further stimulus to technical research, as Dr. Dunsheath himself emphasized, and the Larke Committee has already indicated the dependence of export trade on technical advance and research. If, however, the Committee's hopes that its work will help to harness the great body of scientific ability and experience which Great Britain possesses to the work of industrial development and reconstruction in the post-war period are to be fulfilled, it can scarcely be questioned that some further attempt must be made to co-ordinate and plan the resources available. Every endowment such as the Nuffield Foundation increases the need for co-ordination and ordered development, in order to avoid overlapping and duplication of effort in some fields and frustration and delay in others.

The vital question is in fact one of the machinery of government, and the points which Sir John Anderson made at the annual luncheon of the Parliamentary and Scientific Committee on February 11, although primarily with reference to the relations between science and Government in time of war, are equally pertinent in regard to the organization of scientific research to serve the needs of the nation, both in industry and in society, in time of peace. Sir John Anderson said that any new organization must be firmly built into the Government machine and must not be insulated from the general body of scientific workers outside—two points which are well met in Dr. Dunsheath's proposals. Further, said Sir John, such an organization must not cut across normal Ministerial responsibility, but must be linked with a Minister whose business it is to see that scientific matters which have a bearing beyond special questions shall be properly considered.

What needs to be added here, however, is the proviso that such Ministerial responsibility must be on the lines recommended by the Haldane Committee, with its emphasis on the clarification of functions and the provision of machinery for the continuous acquisition of knowledge and the prosecution of research to furnish a proper basis for policy. A thorough overhaul of the machinery of government is imperative in this as in other fields where reconstruction problems are encountered. This has been the persistent weakness of the present Government, as the reports of the Select Committee on National Expenditure have consistently shown, and the recent

debate of the Beveridge Report is additional evidence. Furthermore, in regard to the organization of industrial research, there enter those large questions of the type of industrial structure, to which Mr. Herbert Morrison has directed attention. Mr. Morrison suggested that, whether or not we turned our national monopolies into public corporations, we could not leave our great basic industries which have developed into something approaching monopolies in that form.

These are urgent questions to which answers must be found, the nature of which is bound to affect in turn the structure of industrial research. It may well be that a number of different solutions may be found to serve best the public interest and provide the necessary safeguards against restriction and monopoly and the incentive to individual enterprise. The public corporation is not necessarily the only appropriate form of management—Mr. Morrison himself suggested that social control might take many forms—and there is American as well as British experience upon which we can draw in the planning of free societies, and securing the measure of public guidance and public accountability necessary in a modern democracy.

These are not matters to be left to industry alone. Dr. Dunsheath's survey indicated how large a part the universities of Great Britain must play in determining the future policy of the country in industrial and scientific research, and his remarks on co-operation between university workers and industry were strikingly endorsed in the statement "Industry and Education" which has since been issued by Nuffield College, where the claim of industry to a higher proportion of the best men from the universities is stressed.

The forging of much closer links between the universities and industry is only in part a matter of mobility, important though that may be. A much freer movement between academic and industrial research would certainly be a great advantage. Closer personal contacts between those engaged on scientific research in the universities, in industry and in Government research establishments would bring great benefits to all three groups. Closer contact in industry between research and production staffs, and between those working in the research associations and those engaged in research and in production in the industries connected with such associations, could clearly make the triple partnership of Government, industry and the universities more fruitful in every way.

Wise as are those suggestions of the Nuffield College statement, neither these alone, nor the further suggestion for better organization of the processes of selection to secure a fuller flow of scientific brains into industry, will be adequate to harness scientific knowledge to the promotion of higher industrial productivity to the extent required to improve the national standards of living. The personnel side is vital, but it must be implemented by the right type of organization, both of research and of industry, and by adequate and efficient machinery of government.

ARTISTS' MATERIALS AND METHODS

Painting Materials: a Short Encyclopedia

By Rutherford J. Gettens and George L. Stout. Pp. vii+333. (New York: D. Van Nostrand Co., 1942.) 3.75 dollars.

SLOWLY but surely the mist which for many a year has enveloped the subject of studio materials and methods is beginning to lift. Probably one reason why it has hung about for so long is that nobody with the requisite knowledge coupled with due detachment has been willing to tackle the task of dissipation. The authors of this book have set about it with a will. Their first attempt was to contribute an article to *Technical Studies* in 1936 on 'supports' (substances like wood, canvas, paper, and so forth, upon which paintings are executed). Since then, they have followed it up with further papers to the same periodical, dealing with adhesives, pigments, solvents, tools and equipment. The volume now before us is composed of all this valuable data—rounded off with a glossary of scientific terms—collated and arranged for easy reference.

There are five sections: 1, mediums, adhesives and film substances; 2, pigments and inert materials; 3, solvents, diluents and detergents; 4, supports; 5, tools and equipment. Within each of these, the arrangement is alphabetical. This plan, as the authors remark in the preface, is somewhat unusual in an encyclopædia where alphabetical sequence might be expected to obtain throughout. The advantage of the present system, however, is that workers in studios and museum laboratories have become so accustomed to it in dealing with the things that interest them, that any other principle would probably suit their purpose less well. For the casual inquirer, this partitioning will present little difficulty in the majority of cases. The entries are so heterogeneous (for example, *alcohol* would be followed by *alembic* in strict dictionary order) that the authors are on safe ground in their preference for a sectional scheme.

Naturally, the amount of space devoted to items tends to be very unequal. Thus *magenta* occupies but five lines, whereas *smalt* takes fully two pages. The cause is largely accidental. When possible a full historical account is given (discovery, early use, development, synthesis) and is so written as to be not only informative but also readable. Quotations from medieval writers occur occasionally, like that from Hans Sachs, the cobbler-poet of Nuremberg (1568), who wrote, in quaint verse, an account of processing rags for paper-making, until at the end they emerged "snow-white in glossy loveliness".

The more austere parts of this work show the care expended upon it. Such are the tables of the physical properties of pigments, organic solvents, drying oils and waxes. They bring together information of great value, probably never before displayed and annotated more clearly. In general, the proof-reading must have been first-class; such very minor slips as can be found are mainly restricted to the glossary. None of them, so far as the present reviewer can discover, is of a kind in the least likely to mislead.

The format is attractive and workmanlike. Most of the line-drawing illustrations occur in the portion dealing with tools and equipment. A number of grinding instruments are depicted, dating from late classical times to the fifteenth century. Another

somewhat unusual set of illustrations shows a collection of paint-brushes in great detail, including six specimens from China. There can be little doubt that not only art-students, but also critics and historians as well as scientific workers, will find much to interest them in these pages. Designed specifically for reference, they can well be read for pleasure.

This being the case, the authors could not have produced their book at a more appropriate moment, so far as Great Britain is concerned. Their labours at the Fogg Art Museum, Harvard University (as the director of that institution says in his introduction), have entailed a close study of chemistry and physics in relation to objects of art. We, on our side of the Atlantic, have heard much of late about the need for a 'balanced' education, if the arts and sciences are both to play their proper parts in building up mature minds. One way of helping to bring this about has been the suggestion of offering courses in the history of science. Excellent as this would be, the need would still exist for showing those whose primary interest is in the arts (in the widest sense) to how great an extent man's mastery over materials, and therefore his progress in that part of civilization, has been dependent upon a slow and painful development of scientific technique throughout the ages. This is not so much the history of science as the history of (perhaps largely unconscious) scientific method, crude at first, but continually gaining in refinement and confidence. No more stimulating book could readily be imagined to form the basis of such a course than that now under review. Admittedly, this was not the authors' direct intention, but it is an additional reason why the warmest of welcomes should be extended to their efforts.

F. IAN G. RAWLINS.

INFLUENZA PANDEMICS: LOOKING BACK AND FORWARD

Influenza

A Survey of the last 50 Years in the Light of Modern Work on the Virus of Epidemic Influenza. By F. M. Burnet and Ellen Clark. (Monographs from the Walter and Eliza Hall Institute of Research in Pathology and Medicine, Melbourne, No. 4.) Pp. viii+118. (Melbourne and London: Macmillan and Co., Ltd., 1942.) 17*s.* 6*d.* net.

JUST ten years have passed since influenza became accessible to laboratory study through the discovery that ferrets could be infected with the causative virus. Since then, much has been added to our knowledge about the influenzas which have been prevalent. Ways have been found of infecting mice and other animals, of growing the virus in developing eggs and in tissue cultures, and of estimating antiviral antibodies. Unfortunately we do not know how to relate all this knowledge to the facts of the world-wide pandemic of 1918–19; we do not know whether that catastrophe is to be laid to the charge of either of the known influenza viruses, A and B, or to some other pathogenic agent. We cannot forget that the pandemic came on the heels of the War of 1914–18, breaking at a time when large numbers of American troops were arriving in Europe. We therefore look rather apprehensively ahead, though taking some comfort from the fact that the last pandemic but one—that of the early '90s—was not associated with widespread wars.

Burnet and Clark have wisely chosen this moment to produce a review of our knowledge of influenza; they summarize first the known facts gained by the study of influenza viruses in the laboratory and then the clinical and epidemiological data about the 1918 pandemic. They make a gallant attempt to explain "1918" in terms of recent knowledge and urge that now is the time to take stock, to make sure what we want to find out if a pandemic comes, and to plan investigations in advance instead of having to improvise them in a hurry.

Their first three chapters on the experimental studies of the last decade will be found of great value for reference by laboratory workers; beyond that, the facts they summarize form a necessary background to any serious planning for defence against another pandemic. These chapters review our knowledge comprehensively and fairly, though there is naturally particular emphasis on work coming from the Melbourne laboratories. One is occasionally irritated by attempts to raise highly questionable statements to the status of fact by blessing them with a "highly probably" or a "doubtless". Can it be justly claimed as "highly probable" that the serological strain causing the 1933 epidemic was mainly of the 'W.S.' type when only a single 1933 strain was ever studied serologically?

Chapters 4 and 5 deal with the history of influenza in recent years and prior to 1918, and then we reach in Chapters 6 and 7 a review of the features of 1918–19. Of great interest is the marshalling of evidence that the sea-quarantine imposed in Australia was responsible for keeping Australia free from the virulent form of the disease until January 1919. A speculative mind must be intrigued by reading that when it did reach Australia, it still went (at least in Victoria) through the three-wave evolution, which characterized its progress through the rest of the world some months earlier. These and many other curious facts have been dug out and presented in a stimulating manner. Naturally, there is great emphasis on the astonishing change in age-incidence of influenzal mortality with the advent of the 1918 'brand' of influenza. The authors try to persuade us that the pandemic virus was peculiarly lethal to young adults because their tissues were so conditioned as to over-react to the noxious agent, killing them in the process. They hold that, if one looks at influenza as a whole, it becomes probable that the pandemic was due to a mutant or succession of mutants arising from pre-pandemic virus, the mutations having been favoured by special circumstances connected with the war. They suggest that such mutants may have differed from 'ordinary' influenza viruses not only in some antigenic character but also in other biological properties, perhaps power to spread very rapidly over respiratory epithelium.

Having reviewed their array of facts, and having attempted to make some sense out of them in the light of a little gentle speculation, Burnet and Clark proceed in their last chapter to discuss the "prevention of influenza". "What," they ask, "can be done?" Quarantine measures are discussed; also the use of bacterial vaccines against secondary invaders. More attention is given to the use of virus vaccines. Killed vaccines given subcutaneously are of undoubted value in the laboratory in protecting ferrets and mice against infection; they may be also against deliberate infection of human volunteers. But against natural

outbreaks in the field, their value is much more questionable. The authors doubt whether in a pandemic "subcutaneous inoculation" would show "more than a minimal effect on incidence". They are attracted by the theoretical advantages of attenuating a virus by egg-passage and giving it up the nose by atomizer in the living state. They think that at short notice a bacteriological laboratory could in a week make enough attenuated virus for 100,000 persons. Yet they grant that as yet no attenuated strain has been found with the necessary combination of negligible virulence and good immunizing powers.

Some excess of optimism peeps out every few pages in another connexion: the authors have been so successful in isolating viruses by amniotic inoculation of eggs straight from human material that they regard this method as of universal application. But one must not forget that influenza viruses differ greatly from one outbreak to another, and that workers in Great Britain and the United States have not found this technique very successful in the outbreaks they have studied.

The reviewer felt that the last chapter fell a little flat after the excellent eight chapters which preceded it, raising such hopes of a thrilling *dénouement*. Perhaps this was unreasonable; it is a lot to ask for a ready-made solution of one of the biggest public health problems of these times.

C. H. ANDREWES.

THE 'FRIENDLY' ARCTIC

Ultima Thule

Further Mysteries of the Arctic. By Vilhjalmur Stefansson. Pp. 256. (London, Toronto, Bombay and Sydney: George G. Harrap and Co., Ltd., 1942.) 10*s*. 6*d*. net.

THE writer of this book is well known for his long campaign to establish the idea of the 'friendly' Arctic. The present volume continues the campaign, although the approach is rather different. The main theme is to prove "the strong hold of classic theory upon the minds of our contemporaries". An appeal is therefore made to history in an attempt to show that Pytheas and Columbus, who, it is argued, knew the facts about Arctic conditions, were better informed than the modern climatologist, who insists that the Arctic is really a cold part of the world.

Such an approach involves much detailed consideration of the exploration of "Ultima Thule", and an impressive body of evidence is produced to prove the thesis. There is some attempt, too, to present both sides of the case. But one can scarcely escape the fact that much of the argument comes very near special pleading. Thus the author quotes from a summary, in the *Scottish Geographical Magazine*, of the views of Dr. Schott on the height of waves: "he considers waves higher than 60 feet can hardly occur, and that 50 feet must be a very exceptional height", and then comments that "this technical journal, then, feels that 60 feet as the maximum height of a wave is probably an underestimate". This argument, in turn, is held to justify the statements of Las Casas and of Ferdinand Columbus that waves of 54 feet "do not show an exaggerated height let alone an absurd one".

The historical method of approach also compels the author to read into early maps his own interpretations. Thus, the famous world map of La Cosa, some of whose knowledge was gained from his intimate association with Columbus, proves really nothing about the Arctic, unless it is that the state of knowledge in 1500 was very confused. This confusion remained long after La Cosa. A better knowledge of the maps of the 'Age of Discovery' would have warned the author that these maps frequently combine speculation and knowledge.

Finally, Mr. Stefansson makes great play with high temperatures recorded from time to time in the Arctic, and proceeds to make a violent attack on orthodox climatologists including R. de C. Ward, whose reputation is established. It cannot be said that these methods make the case any better; on the contrary, they introduce a spirit which is unnecessary in sound argument. It is true, as the reader is told on the dust cover, that Mr. Stefansson "comes to many startling conclusions". It is also true that while the conclusions may startle, they do not always convince the reader. J. N. L. BAKER.

PARASITOLOGY

Introduction to Parasitology

By Prof. A. S. Pearse. Pp. ix+357. (Springfield, Ill., and Baltimore, Md.: Charles C. Thomas; London: Baillière, Tindall and Cox, 1942.) 3.75 dollars.

THIS volume is intended by its author to serve as a guide and companion to a term's course of theoretical and practical instruction in parasitology for biology students. The subject is completely covered from Protozoa to Chordata. The descriptive matter is sometimes very scrappy and occasionally capable of misconstruction, but actual biological details are accurate.

The parasites of man generally receive adequate treatment, but *Sarcoptes Scabiei* is dismissed very shortly and without mention of recent work on its life history. Malaria and hookworm disease are given due prominence in separate chapters. The medical treatment required in human parasitic diseases is included, and on the whole, the facts given are accurate though sometimes outmoded. The surgical procedure advised in the treatment of amœbic dysentery would be unintelligible to a non-medical reader, and has apparently been imperfectly understood by the author. Notes on epidemiology are included where necessary.

The diseases of domestic animals, game and fish are discussed more fully than parasite infections of animals which have no effects on human economy.

An excellent series of line drawings illustrates nearly every subject, and life-cycles of parasites in a host or hosts are clearly and simply portrayed. An introduction explains the terms used and gives a good description of the modes of life of parasites.

It is often difficult to follow the subject matter in the main sections, for the planning and lay-out of the book make it seem compressed. Practical and field work are described.

The final chapter is frankly astonishing. Though possibly suitable in a course of instruction for travelling salesmen, its phraseology is oddly out of place in a scientific work. As a work of reference for biology students and for amateur biologists, the book can be recommended. Better planning and more coherent reading matter could have opened this fascinating subject to a much wider field of readers.

The Revolving Heavens

Astronomy for Observers with the Naked Eye. By Reginald L. Waterfield. Pp. 206. (London: Gerald Duckworth and Co., Ltd., 1942.) 8s. 6d. net.

THE black-out during the War has increased the interest in naked-eye astronomy, and many people who previously gave little or no attention to the subject are now finding how fascinating the study of the heavens can be. Dr. Waterfield's work is primarily for naked-eye observers, and the explanations which are given about the movements of the heavenly bodies, their distribution on the celestial sphere, their relation to one another, etc., will be of immense advantage to the amateur who is so often puzzled to account for many celestial phenomena. A great part of the book is devoted to the solar system, and one chapter deals with the stars and nebulæ, including double stars, variables, novæ, the galaxy and other galactic systems. It seems incongruous to separate the last chapter, "Shooting Stars and Comets", from the other portion of the work which deals with the solar system, as meteors and comets are, of course, solar system bodies. The explanations with the aid of numerous diagrams are very clear, and the book should arouse keener interest in the study of the heavenly bodies.

A few points which may require modification in the next edition are noted. It is doubtful if the explanation on p. 95 of the large appearance of the moon near the horizon is the correct one. Prof. E. G. Boring's experiments at the Harvard Psychological Laboratory suggest that Ames's theory of ocular torsion may supply an explanation. When the eyes are raised, the right eye tends to rotate clockwise, as seen from behind, with respect to the left eye, and this may explain the moon illusion for binocular vision, though further research is necessary. More than two nebulæ can be seen with the naked eye (p. 195) if observers in both hemispheres are assumed; the Magellanic Clouds should have been included. It is very improbable that many, if any, meteors move with a speed of sixty miles a second (p. 197). The high hyperbolic velocities found by the Arizona Expedition are not now generally accepted, and most meteors are members of the solar system, with a maximum velocity of forty-five miles a second. A terrestrial base line of more than a few miles is necessary to compute the real path of a meteor (p. 198); a minimum of twenty miles should be secured, if possible. M. D.

Mathematics

Its Magic and Mastery. By Aaron Bakst. Pp. xiv+790. (London: Chapman and Hall, Ltd., 1941.) 21s. net.

MR. BAKST'S mathematics do not go beyond elementary trigonometry and kinetics, so his book is not likely to attract adult readers outside the teaching profession. But a good many children would find it a real help with their elementary arithmetic, algebra, and geometry, and would pick up a fair amount of elementary physics while doing so. Mr. Bakst reverses the usual order of presentation by beginning with an example and deducing the principle concerned. Thus geometric series are introduced by chain letters and Australian rabbits, kinetics by graphs of railway time-tables, and so on. The whole book is interlarded with jokes, a few of which are good. It would be a valuable addition to most school libraries. But if I were a mathematical master I should recommend my brighter pupils to read Hogben's "Mathematics for the Million", and offer a prize for finding the largest number of mistakes in "Mathematics, its Magic and Mastery". I have detected them on pages 68, 327, and 638, and I expect there are plenty more. Perhaps there is a negative correlation between wisecracking and accuracy. J. B. S. H.

Metallurgical Abstracts (General and Non-Ferrous)

Vol. 8, 1941 (New Series). Edited by N. B. Vaughan. Pp. x+434. (London: Institute of Metals, 1942.)

FEW will dispute the value of a technical abstracting service, particularly under present conditions when every scrap of knowledge is a weapon of war and, like other weapons, useless unless available in the right place, on time. It may not be so generally realized, however, that there is a good deal of romance to be found in such a volume as this. Dipping into it without concentrating on technical topics, one finds many interesting questions posed.

From a rough count it would seem that there are nearly two hundred abstracts from German literature in this volume; about a similar number from the U.S.S.R.; not quite as many from Japan, and an odd one or two from Italy, France and other countries. This may, of course, mean little since it is impossible to judge what proportion these abstracts may be of the total amount of metallurgical research proceeding in the different countries. On the other hand, there is something to be learned from the quality and type of the work described and the reader may be left to spend an interesting, and maybe not unprofitable, evening, colouring the monochrome of "Met. Abs." with the pigments of his imagination.

H. W. G. H.

The Journal of the Institute of Metals

Vol. 67, 1941. Edited by N. B. Vaughan. Pp. xxxii+380+46 plates. (London: Institute of Metals, 1942.)

OF the twenty-five papers which comprise this volume at least half deal with matters of vital practical importance at the present time. Distinction would be invidious but a few titles may be mentioned as typical examples: "Sources of Inaccuracy in Spectrographic Analysis of Aluminium Alloys"; "Unsoundness in Gravity Die-Cast Silicon-Aluminium Alloy Pistons"; "The Rolling of the Magnesium Alloys"; "Causes of Porosity in Tin-Bronze Castings". These provide an adequate answer to those who plead for a more practical outlook on the part of the Institute of Metals.

In addition, two papers from the Research Laboratory of Imperial Chemical Industries (Metals) Ltd. show how fundamental research should be applied to practical problems. Of the remainder, more theoretical in objective, some describe work carried out in the main before the investigators became fully preoccupied with *ad hoc* questions, and some report stages in long-range researches of a type which must not be subject to wars or rumours of war.

It is pleasing to note an interesting paper from Switzerland—and the references therein to the German work of a distinguished metallurgist now contributing to the war effort of American men of science. H. W. G. H.

SCIENCE, COMMON SENSE AND DECENCY*

By DR. IRVING LANGMUIR, For.Mem.R.S.
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UP to the beginning of the present century, one of the main goals of science was to discover natural laws. This was usually accomplished by making experiments under carefully controlled conditions and observing the results. Most experiments when repeated under identical conditions gave the same results. The man of science, through his own experiments, or from previous knowledge based on the work of others, usually developed some theory or explanation of the results of his experiments. In the beginning, this might be a mere guess or hypothesis which he would proceed to test by new types of experiments. If a satisfactory theory is obtained which seems in accord with all the data and with other known facts, the solution or goal of the investigation was considered to have been reached.

A satisfactory theory should make possible the prediction of new relationships or the forecasting of the results of new experiments under different conditions. The usefulness of the theory lies just in its ability to predict the results of future experiments. The extraordinary accomplishments of the great mathematical physicists in applying Newton's laws to the motions of the heavenly bodies gave scientific men of more than a century ago the conviction that all natural phenomena were determined by accurate relations between cause and effect. If the positions, the velocities and the masses of the heavenly bodies were given, it was possible to predict with nearly unlimited accuracy the position of the bodies at any future time. The idea of causation, or a necessary relation of cause and effect, has long been embedded in the minds of men. The recognized responsibility of the criminal for his acts, the belief of the value of education, and thousands of words in our language all show how implicitly we believe in cause and effect. The teachings of classical science, that is, the science up to 1900, all seem to reinforce this idea of causation for all phenomena.

Philosophers, considering many fields other than science, were divided in their opinions. Many went so far as to believe that everything was absolutely fixed by the initial conditions of the universe and that free will or choice was impossible. Others thought that cause and effect relations were mere illusions.

From the point of view of the early classical man of science the proper field for science was unlimited. Given sufficient knowledge, all natural phenomena, even human affairs, could be predicted with certainty. Ampère, for example, stated that if he were given the positions and velocities of all the atoms in the universe, it should be possible theoretically to determine the whole future history of the universe. Practically, of course, such predictions would be impossible because we could never hope to get the necessary knowledge or the time to carry out such elaborate calculations.

A little later, scientific men developed the kinetic theory of gases, according to which the molecules of a gas are moving with high velocity and are continually colliding with one another. They found that the behaviour of gases could be understood only by considering the average motions of the individual molecules. The particular motion of a single molecule was of practically no importance. They were thus taught the value of statistical methods, like those which the insurance company now uses to calculate the probable number of its policy holders that will die within a year.

The theories or explanations which were developed in connexion with the natural laws usually involved a description in terms of some kind of a model. In general, instead of thinking of the whole complex world, we select only a few elements which we think to be important and concentrate our minds on these. Thus, the chemist developed the atomic theory, according to which matter was made up of atoms of as many different kinds as there are chemical elements. These were thought of as small spheres, but no thought was given as to the material of which they were made. When later theories indicated that these atoms were built up of electrons and positive nuclei, this made very little difference to the chemist, for he had not needed previously to consider that aspect of the model. Schoolboys to-day are asked to build model aeroplanes. These must be of such shape that the different types can be recognized when the profiles of the models are seen against a white background. It naturally is not particularly important just what kind of material is used in constructing them. Aeroplane designers build model aeroplanes to be studied in wind tunnels, but these do not need to be provided with motors.

Most of the models which the scientific man uses are purely mental models. Thus, when Maxwell developed the electromagnetic theory by which he explained the properties of light, he thought of a medium through which these waves travelled. This was called the ether. It was supposed to have properties like those of elastic solid bodies. The reason for this choice of a model was that at that time the average man of science had been taught in great detail the theory of elasticity of solid bodies. Thus the magnetic and electric fields could be understood in terms of the familiar elastic properties. At the present time, relatively few students are well trained in the theories of elasticity. The situation is thus reversed and to-day we explain the properties of elastic solids in terms of the electrical forces acting between their atoms. Every student of geometry constructs a mental model when he thinks of a triangle. The mathematical lines that bound the triangle are supposed to have no thickness. In other words, they are stripped of any properties except those that we wish particularly to consider. Most of the laws of physics are stated in mathematical terms, but a mathematical equation itself is a kind of model. We establish or assume some correspondence between things that we measure and the symbols that are used in an equation, and then, after solving the equation so as to obtain a new relation, we see if we can establish a similar correspondence between the new relation and the experimental data obtained from the experiment. If we succeed in this we have demonstrated the power of the mathematical equation to predict events.

The essential characteristic of a model is that it shall resemble in certain desired features the situation that we are considering. On this basis we should recognize that practically any theory has many arbitrary features and has limitations and restrictions

* Retiring Presidential Address of the American Association for the Advancement of Science, delivered on Science Service's "Adventures in Science" series over the Columbia Broadcasting System on December 26, since the meeting of the Association had been cancelled.

imposed by the simplifications that we have made in the development of the theory, or the construction of our model.

Beginning with Einstein's relativity theory and Planck's quantum theory, a revolution in physical thought has swept through science. Perhaps the most important aspect of this is that the scientific worker has ceased to believe that words or concepts can have any absolute meaning. He is not often concerned with questions of existence, he does not know what is the meaning of the question, "Does an atom really exist?" The definition of atom is only partly given in the dictionary. Its real meaning lies in the sum total of knowledge on this subject among men of science who have specialized in this field. No one has been authorized to make an exact definition. Furthermore, we cannot be sure just what we mean even by the word 'exist'. Such questions are largely metaphysical and in general do not interest the modern man of science. Bridgman has pointed out that all concepts in science have value only in so far as they can be described in terms of operations or specifications. Thus, it does not mean much to talk about length or time unless we agree upon the methods by which we are to measure length and time.

For many years, up to about 1930, the new physics based on the quantum theory seemed to be fundamentally irreconcilable with the classical physics of the previous century. Through the more recent development of the uncertainty principle, developed by Bohr and Heisenberg, this conflict has now disappeared. According to this principle, it is fundamentally impossible to measure accurately both the velocity and the position of any single elementary particle. It would be possible to measure one or the other accurately but not both simultaneously. Thus it becomes impossible to predict with certainty the movement of a single particle. Therefore, Ampère's estimate of the scope of science has lost its basis.

According to the uncertainty principle, which is now thoroughly well established, the most that can be said about the future motion of any single atom or electron is that it has a definite probability of acting in any given way. Probability thus becomes a fundamental factor in every elementary process. By changing the conditions of the environment of a given atom, as, for example, by changing the force acting on it, we can change these probabilities. In many cases the probability can be made so great that a given result will be almost certain. But in many important cases the uncertainty becomes the dominating feature, just as it is in the tossing of a coin. The net result of the modern principles of physics has been to wipe out almost completely the dogma of causation.

How is it, then, that classical physics has led to such definite, clean-cut laws? The simplest answer is that the classical physicist naturally chose as the subjects for his studies those fields which promised greatest success. The aim of the man of science in general was to discover natural laws. He therefore carried out his experiments in such a way as to find the natural laws, for that is what he was looking for. He was best able to accomplish this by working with phenomena which depended upon the behaviour of enormous numbers of atoms rather than upon individual atoms. In this way the effects produced by individual atoms averaged out and became imperceptible. We have many familiar examples of this effect of averaging: the deaths of individual human beings cannot usually be predicted, but the average death-rate in any age group is found to come close to expectation.

Since the discovery of the electron and the quantum, and methods of detecting or even counting individual atoms, it has been possible for men of science to undertake investigations of the behaviour of single atoms. Here they have found unmistakable experimental evidence that these phenomena depend upon the laws of probability and that they are just as unpredictable in detail as the next throw of a coin. If, however, we were dealing with large numbers of such atoms, the behaviour of the whole group would be definitely determined by the probability of the individual occurrence and therefore would appear to be governed by laws of cause and effect.

Just as there are two types of physics, classical physics and quantum physics, which have for nearly twenty-five years seemed irreconcilable, just so must we recognize two types of natural phenomena. First, those in which the behaviour of the system can be determined from the average behaviour of its component parts; and secondly, those in which a single discontinuous event (which may depend upon a single quantum charge) becomes magnified in its effect so that the behaviour of the whole aggregate does depend upon something that started from a small beginning. The first class of phenomena I want to call 'convergent phenomena', because all the fluctuating details of the individual atoms average out, giving a result that converges to a definite state. The second class we may call 'divergent phenomena', where from a small beginning increasingly large effects are produced. In general, then, we may say that classical physics applies satisfactorily to convergent phenomena and that they conform well to the older ideas of cause and effect. The divergent phenomena, on the other hand, can best be understood on the basis of the quantum theory of modern physics.

Let me give some illustrations of divergent phenomena. The wonderful cloud chamber experiments of C. T. R. Wilson show that a single high-speed electron, or an alpha particle from an atom of radium, in passing through a gas leaves a trail of ions. By having moisture in the gas and by causing the gas to expand just after these ions are produced, drops of water are made to condense on the ions. By a strong illumination it thus becomes possible to see or photograph this track of ions as a white line on a dark background. The time at which an alpha particle will be emitted from a radium atom is inherently unpredictable. It would be totally contrary to the teaching of modern physics to suppose that our inability to predict such an event is merely due to our ignorance of the conditions surrounding the particular atom. The uncertainty principle requires that even if these conditions were absolutely fixed, the time of emission and the direction of emission of the alpha particle are subject to the laws of chance and thus for a single particle are unpredictable.

The occurrences in the Wilson cloud chamber following the disintegration of a single radium atom are typical divergent phenomena. The single quantum event led to the production of countless thousands of water droplets and these made the track of the alpha particle visible and led to its reproduction in a photograph. This track may show some unusual feature of particular interest to the scientific worker. For example,

it may have a kink which indicates that the alpha particle collided with the nucleus in one of the molecules of gas. The photograph may therefore be published—may start discussions among scientific men that involve thousands of man-hours—may delay one of them so that he misses a train on which he might otherwise have suffered a fatal accident. Examples of these kind, any number of which could be given, show that it is possible for single unpredictable quantum events to alter the course of human history.

The formation of crystals on cooling a liquid involves the formation of nuclei or crystallization centres that must originate from discrete, atomic phenomena. The spontaneous formation of these nuclei often depends upon chance. At a camp at Lake George, in winter, I have often found that a pail of water is unfrozen in the morning after being in a room far below freezing point, but it suddenly turns to slush upon being lifted from the floor.

Glycerine is commonly known as a viscous liquid, even at low temperatures. Yet if crystals are once formed they melt only at 64° F. If a minute crystal of this kind is introduced into pure glycerine at temperatures below 64°, the entire liquid gradually solidifies. During a whole winter in Schenectady I left several small bottles of glycerine outdoors and I kept the lower ends of test tubes containing glycerine in liquid air for days, but in no case did crystals form. My brother, A. C. Langmuir, visited a glycerine refinery in Canada which had operated for many years without ever having any experience with crystalline glycerine. But suddenly one winter, without exceptionally low temperatures, the pipes carrying the glycerine from one piece of apparatus to another froze up. The whole plant and even the dust on the ground became contaminated with nuclei, and although any part of the plant could be temporarily freed from crystals by heating above 64°, it was found that whenever the temperature anywhere fell below 64°, crystals would begin forming. The whole plant had to be shut down for months until outdoor temperatures rose above 64°. Here we have an example of an inherently unpredictable divergent phenomenon that profoundly affected human lives.

Every thunderstorm or tornado must start from a small beginning, and at least the details of the irregular courses of such storms across the country would be modified by single quantum phenomena that acted during the initial stages. Yet small details, such as the place where lightning strikes or damage occurs from a tornado, may be important to a human being.

Much more obvious examples of divergent phenomena which affect human life are those involved in the mechanism of heredity and the origin of species. Whether the genes are inherited from the mother or from the father seems to be fundamentally a matter of chance, undoubtedly involving changes in single atoms. It is known definitely that changes in genes or mutations can be produced by X-rays, and it has even been proved that a single quantum is sufficient to bring about such an alteration. The growth of any animal from a single cell is a typical illustration of a divergent phenomenon. The origins of species and all evolutionary processes, involving as they do natural selection acting upon mutations, must depend at almost every stage upon phenomena which originate in single atoms.

An idea that develops in a human brain seems to have all the characteristics of divergent phenomena. All through our lives we are confronted with situations where we must make a choice, and this choice may sometimes alter the whole future course of our lives. Occasionally such decisions are made by tossing a coin—an event which seems unpredictable—but there is no reason to doubt that single atomic processes, or small groups of them which follow statistical laws, may not often be a determining element.

When certain bacteria are heated until they begin to die, it is found that in successive intervals of time the same fraction of the survivors succumbs. This seems to prove that the life of these cells depends on a single unstable molecule the change of which involves death. It is thus a matter of pure chance as to which particular individuals die within a given period.

The examples that I have given of convergent and of divergent phenomena are purposely chosen as extreme types. Actually there are many intermediate cases that are not clearly one or the other. Or, again, phenomena which start out to be divergent may apparently degenerate into the convergent type. For example, if the photograph of the Wilson cloud track did not prove to be of interest, it would soon be forgotten and might have no further ascertainable effects on human lives. Similarly, in the evolutionary process a new species that originates as a single divergent phenomenon may not survive and its effect soon seems to die out.

We must recognize, nevertheless, that a divergent phenomenon which once occurs permanently alters details of molecular arrangements in the convergent systems that follow it, and thus conditions may be brought about which favour the occurrence of new divergent phenomena. In a world in which divergent or quantum phenomena occur, we can thus have no absolute relation of cause and effect.

As the implications of the uncertainty principle, especially as applied to divergent phenomena, are more generally recognized, the limitation of the idea of causality should have profound effects on our habits of thought. The science of logic itself is involved in these changes. Two of the fundamental postulates of logic are known as the law of uniformity of Nature, and the law of the excluded middle. The first of these laws is equivalent to the postulate of causality in Nature. The second law is simply the familiar postulate that a given proposition must be either true or false. In the past these so-called laws have formed the basis of much of our reasoning. It seems to me, however, that they play no important part in the progress of modern science. The cause and effect postulate is only applicable to convergent phenomena. The second postulate, in assuming that any proposition must be true or false, implies that we attach absolute meanings to words or concepts. If concepts have meanings only in terms of the operations used to define them, we can see that they are necessarily fuzzy. Take for example the statement, "atoms are indestructible". Is this true or false? The answer depends upon what aspect of atoms is considered. To the chemist the statement is as true as it ever was. But a physicist, studying radioactive changes, recognizes that some atoms undergo spontaneous disintegration or destruction. The fact is that the chemist and the physicist have no exact definitions of the word atom, and they also do not know in any absolute sense what they mean by indestructible. Fortunately such questions no longer occupy much of the time of scientific men, who are

usually concerned with more concrete problems which they endeavour to treat in common-sense ways.

It is often thought by the layman, and many of those who are working in so-called social sciences, that the field of science should be unlimited: that reason should take the place of intuition, that realism should replace emotions and that morality is of value only so far as it can be justified by analytical reasoning. Human affairs are characterized by a complexity of a far higher order than that encountered ordinarily in the field of science.

To avoid alternating periods of depression and prosperity, economists propose to change our laws. They reason that such a change would eliminate the cause of the depressions. They endeavour to develop a science of economics by which sound solutions to such problems can be reached.

I believe the field of application of science in such problems is extremely limited. A scientific man has to define his problem and usually has to bring about simplified conditions for his experiments which exclude undesired factors. So the economist has to invent an 'economic man' who always does the thing expected of him. No two economists would agree exactly upon the characteristics of this hypothetical man, and any conclusions drawn as to his behaviour are of doubtful application to actual cases involving human beings. There is no logical scientific method for determining just how one can formulate such a problem or what factors one must exclude. It really comes down to a matter of common-sense or good judgment. All too often wishful thinking determines the formulation of the problem. Thus, even if scientifically logical processes are applied to the problem, the results may have no greater validity than that of the good or bad judgment involved in the original assumptions.

Some of the difficulties involved in a scientific approach to economic problems are illustrated by the following: If we wish to analyse the cause of a depression (or, for example, a war) we should ask ourselves what we mean by the word cause in this connexion. In terms of operations the usual meaning of the word cause is something as follows: it is a common experience, in a study of convergent phenomena, that if a given set of physical conditions are brought about repeatedly at different times, the same result occurs in each case. Except in so far as it is possible to repeat the experiment and get the same result, it is impossible to give a definite meaning to the word cause.

In the case of a depression, or a war, we logically need to produce, or at least to observe, a given set of possible antecedent conditions and to see whether they are always followed by depressions. Since we cannot produce experimental depressions, nor have we sufficient observational data to enable us by statistical means to unravel the enormous number of factors involved, we must conclude that the word cause as applied to a depression has an extremely fuzzy meaning.

When we consider the nature of human affairs, it is to me obvious that divergent phenomena frequently play a part of vital importance. It is true that some of our historians cynically taught most of our college students from 1925 to 1938 that wars, the rise and fall of a nation, etc., were determined by nearly cosmic causes. They tried to show that economic pressure, and power politics on the part of Great Britain or France, etc., would have brought the same result whether or not the late German emperor or Hitler or any other individual or group of individuals had or had not acted the way they did. Germany, facing the world in a realistic way, was proved almost scientifically to be justified in using ruthless methods —because of the energy and other characteristics of the German people they would necessarily acquire and should acquire a place in the sun greater than that of Great Britain, which was already inevitably on the downward path. I can see no justification whatever for such teaching that science proves that general causes (convergent phenomena) dominate in human affairs over the results of individual action (divergent phenomena). It is true that it is not possible to prove one way or the other that human affairs are determined primarily by convergent phenomena. The very existence of divergent phenomena almost precludes the possibility of such proof. The mistaken over-emphasis on convergent phenomena in human affairs, and the reliance on so-called scientific methods, has been responsible in large degree for much of the cynicism of the last few decades.

The philosophy which seems to have made the German people such willing aggressors is allegedly based upon scientific realism. Almost any system of morality or immorality could receive support from the writings of Nietzsche, so inconsistent are they with one another. But his teachings, which purport to be based on the laws of natural selection, have led in Germany to a glorification of brute strength, with elimination of sympathy, love, tolerance and all existing altruistic emotions.

Darwin himself, however, recognized that the higher social, moral and spiritual developments of mankind were factors which aided in survival. This is often referred to loosely as the law of the survival of the fittest. The concept of fitness seems, however, inherently rather fuzzy. Apparently those individuals are fittest who possess characteristics that increase the probability that they shall survive. We often hear realists deplore the effects of charity which tend to keep the unfit alive. We are even told that the whole course of evolution may be revised in this way. Similar arguments could be used against the surgeon who removes an appendix or a doctor who uses a sulpha drug to cure pneumonia.

But what is the need of developing a race immune to appendicitis or pneumonia, if we possess means for preventing their ill effects? The characteristics that determine fitness merely change from those of immunity to those which determine whether a race is able to provide good medical treatment.

The coming victory of the United Nations will prove that survival of the nation may be prevented by an aggressive spirit, by a desire to conquer or enslave the world, or by intolerance, ruthlessness and cruelty. In fact, there is no scientific reason why decency and morality may not prove to be vastly more important factors in survival than brutal strength.

In spite of the fact that we can no longer justify a belief in absolute causation and must recognize the great importance of divergent phenomena in human life, we still have to deal with causes and effects. After all, we must plan for the future. We can do this, however, by estimating probabilities even where we do not believe that definite results will inevitably follow. When an American army lands in North Africa, its probable success depends on the carefulness of the preparations and the quality of the strategy. But no amount of foresight can render success absolutely certain.

It does not seem to me that we need be discouraged if science is not capable of solving all problems even in the distant future. I see no objection to recognizing that the field of science is limited. In the complicated situations of life we have to solve numerous problems and make many decisions. It is absurd to think that reason should be our guide in all cases. Reason is too slow and too difficult. We often do not have the necessary data; or we cannot simplify our problem sufficiently to apply the methods of reasoning. What then must we do? Why not do what the human race always has done—use the abilities we have—use common sense, judgment and experience. We often underrate the importance of intuition.

In almost every scientific problem which I have succeeded in solving, even those that have involved days or months of work, the final solution has come to my mind in a fraction of a second by a process which is not consciously one of reasoning. Such intuitive ideas are often wrong. The good must be weeded out from the bad—sometimes by common sense or judgment—other times by reasoning. The power of the human mind is far greater than one ordinarily thinks. We can often size up a situation, or judge the character of a man by the expression of his face or by his acts, in a way that would be quite impossible to describe in words.

People differ greatly in their ability to reach correct conclusions by such methods. Our superstitions and the present popularity of astrology prove how often our minds make blunders. Since we have to live with our minds, however, we should train them, develop them, censor them—but let us not restrict them by trying to regulate our lives solely by science or by reason.

Our morality is a kind of summation of the wisdom and experience of our race. It comes to us largely through tradition or religion. Some people justify evil things on the basis of morality—but by and large a recognition of right and wrong, even if these concepts are sometimes fuzzy, has proved to be of incalculable value to mankind. The philosophical, metaphysical or even scientific analysis of the principles of ethics has not proved particularly fruitful. A sense of morality and decency, although not scientific, may be a major factor in winning the War.

BIOCHEMISTRY AND CHEMOTHERAPY

By HENRY McILWAIN

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THE conception that drugs act by metabolic interference has been latent in pharmacology throughout the growth of chemotherapy and biochemistry. This note traces its development to the status of a working hypothesis. Knowledge in detail sufficient for such a hypothesis scarcely existed before 1900, but earlier writers were aware of some relevant principles. Thus Loew[1] attempted to classify poisons according to the nature of their primary interaction with cells; he assessed the available knowledge of their effects on cell components, including ferments, the nature and independent existence of which were then open to doubt. Other writers, for example, Brunton[2], also showed a healthy curiosity concerning the relation of such processes as nutrition and respiration to the action of drugs. Respiration could at that time be recognized not only as a process affecting the whole of an organism, but also its parts, as the hæmoglobin-oxyhæmoglobin change had long been known, and Ehrlich's early work had demonstrated reduction and oxidation of dyes in tissues.

Receptor Theories

It is important to the development of the subject that before such phenomena had become sufficiently understood in material, that is in enzymic, terms, medical workers were forming independent ideas of the nature of the functioning parts of cells. These were expressed in the receptor or side-chain theories, which originated in explanation of immunological phenomena and hence had little experimental connexion with metabolism. They, however, embodied in hypothetical form the rudimentary biochemical knowledge of the nineteenth century.

Ehrlich considered, in his classical presentation[3] of the side-chain theory, that bacterial and other toxins combined with portions ('side-chains') of the cell, which were normally concerned with processes of nutrition, and that toxic action was due to this blocking of their normal action. The term 'side-chain' arose from the realization that there must be portions of living cells accessible to ordinary chemical reactions, and the name was loosely borrowed from organic chemistry to express this. There was little or no experimental connexion with nutritional processes, and much of the circumstantial evidence offered by Ehrlich in 1900 is now recognized as open to alternative explanation. Nevertheless the theory was widely adopted, perhaps because it was expressed in material terms, hypothetical though these were. It was also widely applied, and it was inevitable that drug action should be interpreted in similar terms. Such was done by Langley in 1909[4], if not before.

Ehrlich's work on chemotherapy, which made it a separate subject, was carried out between 1905 and 1915. At this time much more was known of enzymes as the functioning parts of cells than was the case when the receptor theory arose, but little or no advantage was taken of this knowledge. It is understandable that the impetus of Ehrlich's successful interpretation of immunological phenomena should lead him to adopt the current suggestion that drugs acted at side-chains or receptors. This he did[3], though in his earlier account[5] he had emphasized the difference, in type of combination, between toxins and alkaloids. The transfer of ideas was nevertheless easy, as both immunology and chemotherapy were largely concerned with micro-organisms. His approach to chemotherapy through study of dyestuffs held the subject firmly to the conception of material combination of the inhibiting agent with the affected organism, and direct experiment confirmed such combination. This led to his peopling the cells with arseno-receptors, acetico-receptors, and orthoamidophenol-receptors. Though he recognized such receptors as having some vital part in the cell-economy, the relation remained hypothetical, and the functions ascribed to the receptors were the nutritional and respiratory processes suggested some twenty years before. Yet by 1909 or 1913, enzyme processes had been subjected to detailed investigation, and monographs[6] concerning them were available. Examples of the union of substrate and inhibit-

ing compounds with enzymes which would provide a realistic mechanism for the combination of simple compounds with functioning parts of cells had been known for some time; E. F. Armstrong[7] traced the development of the concept from 1879. Chemotherapy, from its initiation as a separate subject, was out of touch with contemporary biochemistry.

This separation has to a large extent been maintained by chemotherapists, and in considering reasons for this, it can be realized that the receptor ideas and nomenclature, and Ehrlich's making of chemotherapy a chemical rather than biochemical study, were firmly impressed upon the subject by his great practical achievements. Such results frequently tend to rigidify a subject, in conceptions as well as in technique. It was particularly unfortunate that theories concerning the functioning of receptors were twenty years old before they were applied to chemotherapy, for this resulted in biochemical understanding being fixed not at the level of 1910, when it could be tentatively suggested that enzymes were 'side-chains'[8], but at the level of 1890. Further explanation may lie in the types of enzymes which had been studied at this period, for investigation of hydrolytic or digestive processes preponderated over studies of energy-yielding or intracellular reactions which could be considered more important to the cell and more relevant to the action of poisons. There was, however, evidence for enzymic mechanisms in many of these more 'vital' processes, zymase, alcohol oxidases, catalase and the Schardinger enzyme being among those which had been investigated by 1903[9].

Nutritional hypotheses of drug action similar to that embodied in the receptor theories have since been used by Braun and Schaeffer[9], Stearn and Stearn[10] and von Jancsó and von Jancsó[11]. The early impression that some antibacterial agents affect respiratory processes has been refined by Dubos[12] and Fildes (see ref. 25) in terms of *Eh*, but other factors also were found to be involved.

Biochemical Theories

In the meanwhile, many biochemical investigations had involved the use of drugs, including chemotherapeutic agents. The use of inhibitors has been a common technique throughout enzyme investigation, having been employed by Buchner and earlier workers; the effects of most drugs on enzyme systems have been studied, and many found inhibitory[13]. Thus, apart from general protein precipitants and the more specific precipitation of certain enzymes by dyes, cyanides inhibit many oxidases; atoxyl and quinine inhibit some lipases at extremely high dilutions; cocaine, atropine and pilocarpine inhibit yeast invertase. More important, explanations have been offered of the physiological or chemotherapeutic actions of drugs in terms of their effect on enzymes or similar systems; the classical example is the action of cyanides or carbon monoxide on hæmoglobin. Myrbäck[13] made the general statement that enzyme inactivation was probably the mode of action of poisons on cells. Quastel[14] made, with reservations, a similar statement in a specific case from correlation of trypanocidal with anti-fumarase activity of a number of compounds. Scheff and Haskó[15] to some extent refined respiratory hypotheses of drug action in stating from metabolic work that acriflavine affected a cyanide-insensitive hydrogen-transporting system in trypanosomes. Evidence also accumulated of the similarity of the action of narcotics on enzyme systems and on whole organisms[16]. Reversibility of action was common to both, and the action in each followed Traube's rule in showing a regular geometrical increase in activity in ascending homologous series. This quantitative correlation was emphasized, as physico-chemical methods of investigating drug action were considered of primary importance.

The first clear recognition of an enzyme as the site of action of a drug, however, came independently of such work, and through physiological investigations into a process which appeared at first to be a side-reaction, namely, the destruction of acetylcholine in tissues[17]. Stimulation of the vagus liberated a material similar to acetylcholine, and the effects of stimulation or of acetylcholine were normally transitory, but were prolonged by eserine. The interpretation of the transitory action of acetylcholine in terms of its enzymic destruction was natural, as study of the fate of administered drugs was a subject in common to pharmacology, chemotherapy and biochemistry. Thus, activation of pentavalent arsenicals by reduction to trivalent compounds was known, as was the excretion of drugs in conjugated forms. The necessary feeding experiments constituted one of the earliest techniques of biochemistry. Recognition that the breakdown of acetylcholine was due to its esterase, and that eserine, which inhibited the breakdown, acted on the enzyme, was therefore the major transition which resulted in giving a satisfactory biochemical mechanism to the action of eserine. This was achieved by Loewi and Navratil in 1926[17]. It has since been made probable that ephedrine and certain other compounds potentiating adrenaline act in a similar manner[18].

Application of Biochemical Knowledge

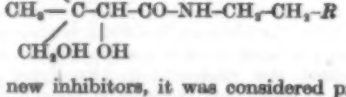
The knowledge that some drugs act at enzymes is not, however, a sufficient basis for development of new drugs, as the nature and importance of most enzyme reactions of organisms are unknown. Thus the effects of many chemotherapeutic agents on enzyme systems in micro-organisms have been studied, but in most cases the relation of the actions observed to the specific chemotherapeutic action of the drugs are unknown. The administration of general enzyme poisons is not likely to be very practical, though dosing with, for example, chloroacetate has been tried on the basis of its action on the enzymes of the parasite[19]. As was recognized as necessary by the receptor theory, a greater specificity is needed. So little is known of the details of enzyme action that the problem of identifying essential enzymes in cells, and of devising specific inhibitors for them, does not at first glance appear a problem any simpler than designing on the basis of receptor theories. A possibility has, however, been afforded by the simpler components of enzyme systems, their coenzymes and substrates. It has been known at least since 1904[7] that substances structurally similar to normal substrates or products of enzymes may, if added together with the substrate, prevent or retard its breakdown. This was found true both of compounds which were acted upon by the enzyme, and—what is more important in the present connexion—others which are not acted upon. Thus, hydrolysis of many sugars is inhibited by other sugars and by glucosides. Dehydrogenation of lactate (I, $R = CH_3$) to pyruvate (II, $R = CH_3$) is inhibited by a series

(I) *R*–CHOH–COOH (II) *R*–CO–COOH

of compounds[20], including α-hydroxybutyric acid (I, $R = C_2H_5$), glyceric acid (I, $R = CH_2OH$), mandelic acid (I, $R = C_6H_5$), glyoxylic acid (II, $R = H$), and oxalic acid (II, $R = -OH$), but not by some related compounds which do not contain groupings in common with the substrates of the enzyme. Succinic dehydrogenase is similarly inhibited by compounds containing the group $-CH_2-COOH$, notably by malonate.

When knowledge of the chemical structures of coenzymes became available in the last decade, it was realized that metabolic processes depended upon the actions of relatively small amounts of organic compounds which bore at least superficial resemblance to the molecules of inhibitory compounds. Thus Dickens[21] pointed out the similarity between coenzymes I and II and riboflavine, on one hand, and on the other, pyridine, quinoline and acridine compounds which were inhibitors. The relation of this to their functioning as inhibitors was, however, speculative, and Woods's work with sulphanilamide and *p*-aminobenzoate[22] was probably the first demonstration of functional relationship between a chemotherapeutic agent and a structurally related natural compound.

Antibacterial agents are required to delay or prevent bacterial growth, and compounds essential to bacterial growth have been known for some time from studies of bacterial nutrition[23]. Many such growth factors are identical with vitamins and other essentials in animal nutrition, and suggestions have frequently been made that they may function as coenzymes[24]. Whether this is so or not, their utilization, which is essential to growth, presumably involves enzyme reactions. The attempt to prepare inhibitors of bacterial growth by modifying the structures of substances which promote bacterial growth therefore affords at the same time a possibility of testing biochemical ideas concerning the nature and action of chemotherapeutic agents, and of the developing of new agents[25, 26]. Analogues of aliphatic aminocarboxylic acids, of nicotinic acid and its amide, of tryptophan and of pantothenic acid (III, $R = -COOH$) have therefore been tested as antibacterial agents. In most cases, growth was inhibited, and the inhibitions could be shown to be related to the structurally similar metabolites.

(III) 

Of the new inhibitors, it was considered probable from *in vitro* experiments that pantoyltaurine (III, $R = -SO_3H$) would be active *in vivo* against hæmolytic streptococci[27]. This followed from a biochemical understanding of its action, which was to prevent the parasite utilizing the host's pantothenate. Pantothenate was found to be the main natural antagonist of the inhibitor; its concentration in animal tissues was determined and an estimate made of the amount of pantoyltaurine necessary *in vitro* for inhibition of hæmolytic streptococci in presence of the naturally-occurring concentration of growth-factor. It was probable that this quantity would be active *in vivo* as the action of sulphanilamide, though like that of pantoyltaurine varying from bacteriostasis to complete inactivity in different media, had a definite action in the presence of a defined quantity of its antagonists, and this regularity of action extended to *in vivo* conditions[28]. Pantoyltaurine has now been found active *in vivo* at the level indicated, its subcutaneous injection protecting rats from intraperitoneal infection with 10^4 (and partly from 10^6) times the minimum lethal dose of hæmolytic streptococci[29]. Moreover, the *in vivo* action was annulled by an amount of pantothenate which *in vitro* experiments showed to be a limiting quantity. This is a necessary point, as there are instances of therapeutic agents being designed by arguments which bear little relation to the actual mechanisms by which they act, including Perkin's preparation of the febrifuge acetanilide through a partly understood quinine formula. As could be expected from the line of argument which led to the production of pantoyltaurine, its action is distinct from that of sulphanilamide and is not affected by *p*-aminobenzoate; this confers the practical advantage of activity against some sulphonamide-resistant organisms.

The connexion which has been achieved by biochemical methods between *in vivo* and *in vitro* drug action in the cases of sulphanilamide and pantoyltaurine is satisfying only in comparison with the previous lack of correlation. It leaves undefined the precise degree of *in vitro* bacteriostasis which is associated with disinfection *in vivo*. A biochemical attitude to chemotherapy has, however, led also to a greater understanding of some of its problems, such as chemotherapeutic interference and the nature of drug-fast strains[26]. An instance of synergism has also been explained in nutritional terms, the potentiation of sulphanilamide by azochlorimide being referred to the latter's destruction of *p*-aminobenzoate[30].

Conclusion

In conclusion, it must be emphasized that the interrelation of biochemistry and chemotherapy is in its very early stages. Competitive inhibition, even when it involves the preparation of new metabolite analogues as inhibitors, is a relatively crude and elementary application of biochemical knowledge. At present, it scarcely involves thinking of living organisms as the integrated series of partly balanced reactions which are known to be involved. The action of all drugs is not by substrate competition, though some have received alternative biochemical explanations. Also, much of our knowledge of enzymes has come from studies of their inhibition, and details of their structure and action are among the major problems of biochemistry, the solution of which hypothetical relations such as the present can usefully promote. Their present achievements are, in summary, the specifying of the functions of some drug receptors; the corollary that many known enzymes can be regarded as potential drug-receptors; the developing of general nutritional methods for the investigation of drug-action; the ability to use such findings for the development of new inhibitory agents, and in general a practical connexion with current biochemical work.

Though the theories and observations on biochemical aspects of drug action which have been recounted present relatively continuous lines of development, there is surprisingly little reference by a given author to his predecessors. Also, other aspects of drug action received much more attention during

this half-century, notably those with physico-chemical rather than biochemical basis. This was probably part of the generally slow recognition of enzyme processes as the mechanism of cell events, to which Gowland Hopkins referred in 1913[31]. Perhaps at the beginning of the century the progress of chemotherapy was best served by emphasizing its separateness from the rest of pharmacology[32], as did Ehrlich, but there is little doubt now that it will progress best in association not only with pharmacology, organic chemistry, and bacteriology, but also with biochemistry and much of general biology, and by its practical impetus contribute to the progress of all these subjects.

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OBITUARIES

Dr. H. G. Stead

"WE have, indeed, suffered a severe and heavy loss at an important and formative period in the history of British education." This is the tribute and the regret of the President of the Board of Education, at the death on January 3 of Dr. H. G. Stead. Into his fifty-four years Dr. Stead had packed more than most men. First assistant master at a primary school, then mathematics master at a grammar school, then a lecturer in a technical school, he had a wide and varied experience 'at the blackboard' such as few of our educational administrators possessed. Perhaps that goes a long way towards explaining why his lectures and his writings were always so impressively concrete and so gladly received by teachers.

When he became an administrator, Dr. Stead did not cease to be an educator. His vision was clear and his energy and enthusiasm impressive. This unusual combination of idealism and realism was largely responsible for making the small borough of Chesterfield something of a Mecca for educationists. Here they could see in workaday operation many of the reforms for which Dr. Stead had so vigorously pleaded; here they could come for the refreshing experience of his conversation; and here for the first time many who had been influenced by his writings came to appreciate the grave physical disabilities under which he suffered.

For those who knew him well, Dr. Stead's triumph over the results of his war injuries was an inspiration. Daunted neither by late hours nor Derbyshire snows, he would battle through to his small adult class in a neighbouring village; and if by any chance he could not get back home to Ashover, he knew that he had many friends who would be delighted to entertain him. This gift of friendship was perhaps one of Dr. Stead's most striking characteristics. His vision was so penetrating and his wit so sharp that he might well have alienated his acquaintances; but always there was that mischievous twinkle in his eye to save the situation and to cement the friendship.

After retiring from his administrative post, Dr. Stead became organizing secretary of the New Education Fellowship, and gave full rein to his evangelism. Touring the country under war-time travelling difficulties, doubled by his physical disability, he brought to meetings large and small a realization of the social context of educational reform. His latest book, "The Education of the Community", stands out from most others in its crystal clarity and its uncompromising honesty. Add to those two qualities the two others of a gently mischievous humour and an indomitable will, and there is a portrait of Harry Stead.

CYRIL BIBBY.

IF, as there is good reason for believing, an Education Bill is shortly to be presented to Parliament, no one man's contribution towards that desirable end has been greater than the contribution of Dr. H. G. Stead. His professional experience for the work he was doing was admirably wide and varied. This enabled him, practically and expertly, to examine the education system and to make sound and far-reaching proposals for its improvement; but merely to say that he made proposals would be to present a thin and colourless picture of Stead. The real picture is one of a colourful, dynamic yet intensely sympathetic personality. He did not merely examine the education system in the manner of the cold and careful administrator. He had formed his own very clear ideas concerning reforms which he was deeply convinced were essential to the practical implementation of the democratic ideal. He wrote prolifically about his ideals; he went about the country tirelessly and persistently and lectured about them. He read and he listened to those who appeared to differ from him on method or principle, but everyone with whom he talked or worked or argued recognized his brilliance, his clear vision of the shape of things to come, and, above all, his kindliness and his passionate sincerity. It is difficult, at this juncture, to sum up his work. Generalization is notoriously difficult and uncertain, but in the planning of the new system which he envisaged, it seems clear that, if civics be the "most architectonic of the arts", he pointed the way by which that art might illumine and widen both the process and end of education.

J. WICKHAM MURRAY.

NEWS and VIEWS

Food Yeast

BECAUSE, in contrast with animal protein, plant protein is poor in some of the B vitamins although rich in others, it is important to supply the missing types to human and animal diets when plant protein is consumed. Recently it has been found that micro-organisms build up all the members of the vitamin B group and that their protein is of the same high nutritive value as animal protein. These facts have been the basis of recent work at the Chemical Research Laboratory, Department of Scientific and Industrial Research, which has led to the production of 'Food Yeast'. For the factory in Jamaica, an organism has been developed at the Laboratory from a yeast used during the War of 1914–18 for feeding purposes, though at the time nothing was known about its vitamin content. The organism developed is double the size of that originally tried. This facilitates large-scale manufacture and the product is somewhat richer in some of the B vitamins than the original type. When dry it contains as much as 50 per cent of high-grade protein, approaching in nutritive value to meat and fish protein. Its vitamin B content is definitely higher than that of animal protein, including liver.

The product known as 'Food Yeast', which has resulted from the researches of the Chemical Research Laboratory, has a slightly meaty taste and is of a light straw colour. It can be mixed with water or milk or added to soups and stews, to which it imparts a pleasant meaty taste. It could be successfully incorporated into biscuits and could, if added to flour, yield a most palatable loaf; 5 per cent of it, added to a 2 lb. loaf, would increase its nutritive value as much as would the addition of a $\frac{1}{4}$ lb. of beefsteak or two eggs. Food Yeast can be produced from waste molasses when nitrogen in the form of ammonia or ammonium salts is added, and its production is extremely rapid. A continuous process has been developed: a solution of molasses and the necessary ammonia and phosphate enter one end of a vat, and an equivalent volume of yeast in suspension is withdrawn from the other. Thus a product containing a high concentration of B vitamins and a high-grade protein is made in a matter of hours. This may be significant during the immediate post-war period when the depleted animal stock of Europe will be insufficient to provide meat and milk for the underfed populations of the occupied countries. In the tropical and sub-tropical countries it may also find an important application, for native diets are often deficient in vitamin B. It is estimated that Food Yeast can be supplied at 6*d*. per lb., and $\frac{1}{2}$ oz. taken daily would ensure to the native a sufficiency of B vitamins.

Great Britain and Latin American Culture

THE British Council was first established at the end of 1934 with the purpose of disseminating in foreign countries knowledge of the English language, British institutions and British contributions to science, medicine and the arts. Since then, a large network of institutes has grown up under the Council's auspices in Latin America, as in other parts of the world. But a one-way cultural programme is incomplete: what is needed is a two-way traffic of cultural relations. It is no less desirable that people in Britain should be informed of Latin American life and thought than that Latin Americans should be informed about British thought and customs. The anonymous donation of £30,000 received by the British Government for the promotion of cultural relations with Latin America is thus most opportune. The donors have asked that the gift be at the disposal of the Secretary of State for Foreign Affairs and the chairman of the British Council. They have decided that £20,000 is to be set aside as part of the British contribution to the establishment of an Institute of Latin American Culture in London after the War. One of the projects which will be carried out with the remainder will be the provision of a science laboratory for an important boys' school in South America, conducted on British lines. This news will undoubtedly have an encouraging effect in the Latin American Republics. It will show them that Great Britain wants, not to impose British cultural propaganda on them, but to secure exchange of information on a basis of equality.

Czechoslovak Degrees at Oxford

A UNIQUE ceremony was performed in the Sheldonian Theatre, Oxford, on February 27, when the Vice-Chancellor of the University presided, at the request of the Czechoslovak Government, at the conferment on a group of Czechoslovak medical students of degrees of their own universities. The occasion had a practical and also a symbolic aspect. Czechoslovak students who have been able to complete their studies in Great Britain were thus acknowledged as trained workers, and given a status which will be readily recognized in their own country when the time comes for them to return and minister to their own people. They will not have to labour under the disadvantages sometimes inherent in possessing 'foreign' qualification. But there is also the wider significance of the event. One of the old universities of Great Britain, through its highest resident official, the Vice-Chancellor, gave itself for the time being to the use of the universities of Czechoslovakia, so that the jealously guarded privilege of the conferment of degrees might still be theirs. The difference between the treatment accorded to university and other students by the United Nations and by the Axis Powers needs no emphasis here: it is sufficient to refer to the numerous measures which have been taken to facilitate the continuance of their studies by foreign students in the free countries, and to contrast these conditions with the wholesale persecution to which they have been subjected in occupied Europe. The ceremony at Oxford was a fitting mark of the international character of learning.

Agriculture and Nutrition

MR. F. LE GROS CLARK delivered on February 19 the first of a series of lectures arranged by the Harpenden Branch of the Association of Scientific Workers on "Agriculture and World Nutritional Needs". Speaking on "The Problems of a Freedom from Want Economy", he pointed out that in implementing the principles of the Atlantic Charter, the first need is the acceptance of standards of suitable nutrition applicable with slight modification to populations in all parts of the world. Such standards can easily be agreed upon and should be subject to regular adjustment as knowledge advances. When these standards are applied to existing populations, it appears that in the world as a whole food production has fallen far short of requirements. In a given population, changes in income-level invariably

produce such changes in diet as indicate that the low nutritional-level of the major sections is more a function of economic conditions than of racial tradition or disposition. The exported food of the world as a whole shows a markedly erratic distribution: for example, the English-speaking countries and parts of Western Europe absorbed in times of peace almost the whole of the fruit and sugar which came on to the world markets. What is to be the policy of these favoured countries in a world governed by the principles of the Atlantic Charter?

Social and Industrial Environment and Disease

HIPPOCRATES, in a famous passage, said that in forming a judgment on the outcome of illness not only the individual nature of the patient but also his environment, physiological and psychological, must be considered. This formed the text for a Chadwick Public Lecture delivered on February 23 by Prof. M. Greenwood, who suggested practicable lines of study for the medical student. In the first place, some knowledge of the housing position of England and Wales, as it was and is, is necessary. It is easy to forget that, in some parts of the country, the housing position is still very bad, and that re-housing schemes have not always been successes. In the next place, although scientific study of the influence of occupation on health is hundreds of years old, the earlier work was mainly devoted to specific occupational hazards, the noxious dusts and fumes. More general work on environmental effects is a generation old, but has been greatly neglected in education. Evidence of this is that at the beginning of the present war, and indeed still, the work of the Health of Munition Workers Committee and its successor, the Industrial Health Research Board, has been very largely ignored. One reason for this is that medical students and practitioners, overburdened by the demands of an ever-lengthening curriculum, have neither the training nor the leisure to study papers often of a technical character written by research workers who are usually not members of the medical profession. To prepare the way for improvement it is desirable that all medical students should receive an elementary training in statistical method. Both epidemiology and general social hygiene, because they are concerned with groups rather than individuals, must employ methods of averaging, that is, statistical methods. It is also necessary that more serious attention should be paid to the study of psychology.

Institute of Chemistry

AT the sixty-fifth annual general meeting of the Institute of Chemistry, Dr. J. J. Fox, the retiring president, said that the roll has increased to 8,250 fellows and associates and more than 950 students. The Institute has joined with the Institute of Physics and representatives of other sciences in forming a Joint Council of Professional Scientists to watch their common interests and give expression to the opinions of professional scientists as occasions arise. The Joint Council is in touch with the appropriate authorities in considering the probable position of scientific workers after the War. There has been much discussion among chemists on the future policy of the Institute and on the possibility of closer co-operation between the various organizations devoted to the science and profession. The main objects of the Institute are to promote the education and training of professional chemists, to hold examinations, to grant certificates of competency, to organize and register the competent, and to render every possible assistance to the Government, industry and commerce by encouraging the employment of chemists. Endeavours to promote co-operation at the present time by means of joint membership have not been so well supported as had been hoped by the Chemical Council, a body constituted under a deed of agreement between the Institute, the Chemical Society and the Society of Chemical Industry, which has now been asked to consider the possibility of co-ordinating the services performed by the various bodies for chemists and chemistry. Prof. Alexander Findlay, of the University of Aberdeen, has been elected president of the Institute.

University of London

THE title of professor emeritus of botany in the University of London has been conferred on Prof. R. Ruggles Gates on his retirement from the chair of botany at King's College.

The degree of D.Sc. has been conferred on: Mr. A. G. Gaydon (Imperial College of Science and Technology); Mr. S. H. Jenkins (Rothamsted Experimental Station); Mr. J. T. Martin (Rothamsted Experimental Station); Mr. C. B. Taylor (Rothamsted Experimental Station); Mr. A. F. B. Zeuner (Institute of Archæology).

The William Julius Mickle fellowship has been awarded to Prof. E. C. Dodds, Courtauld professor of biochemistry in the Middlesex Hospital Medical School.

Foreign Books and Translations

MR. JOHN HAMPDEN, director of the Books and Periodicals Department of the British Council, is appealing for books of every type in Arabic, Chinese, Czech, Danish, Dutch, modern Greek, Norwegian, Polish, Serbo-Croat and Urdu for presentation to institutions and individuals in the British Empire, foreign countries and among men of the Allied fighting services and merchant seamen in Great Britain. Standard works, including advanced text-books, in French are also required. Translations into any of these languages of standard works in English would be particularly welcome. Offers should be addressed to the British Council (Foreign Books), The College, South Leigh, near Witney, Oxford.

Social Welfare in the Colonies

A COLONIAL Social Welfare Advisory Committee has been appointed by the Secretary of State for the Colonies to advise him on problems affecting the social welfare of urban and rural communities in the Colonies, on the training of social welfare workers, and on allied matters. The Committee consists of: The Duke of Devonshire, Parliamentary Under-Secretary of State (*chairman*); Sir Charles Jeffries, Assistant Under-Secretary of State (*vice-chairman*); Prof. A. M. Carr-Saunders, director, London School of Economics and Political Science; Miss Margery Fry, well-known authority on juvenile delinquency; Miss L. Harford, chief woman officer, National Council of Social Service; Mr. J. Longland, director of education, Dorset; Mr. E. H. Lucette, secretary, Dr. Barnardo's Homes; Miss Margaret Nixon, chief superintendent of welfare at the Admiralty; Mr. A.

Paterson, Prison Commissioner; Dr. Audrey Richards, Social Services Department, Colonial Office; and Miss Eileen Younghusband, principal officer for training and employment, National Association of Girls' Clubs.

Royal Society of Edinburgh: New Fellows

THE following have been elected ordinary fellows of the Royal Society of Edinburgh: Dr. A. T. Andreasen, principal of the Orissa Medical School, India; Mr. A. H. R. Ball, rector of the Royal High School, Edinburgh; Mr. J. G. Chalmers, Chemistry Department, University of Edinburgh; Mr. J. B. Crawford, treasurer of the Bank of Scotland, Edinburgh; Dr. R. G. M. Dakers, Heriot-Watt College, Edinburgh; the Right Hon. William Y. Darling, Lord Provost of the City of Edinburgh; the Right Hon. John Dewar, Baron Forteviot of Dupplin; Mr. N. Dobson, Ministry of Agriculture's Veterinary Laboratory, Weybridge, Surrey; Dr. A. Dunbar, Edinburgh; Dr. H. R. Fletcher, Government botanist, Edinburgh; Prof. R. Fürth, Dewar research fellow, University of Edinburgh; Prof. J. H. Gaddum, professor of materia medica, University of Edinburgh; Prof. A. C. Hardy, regius professor of natural history, University of Aberdeen; Mr. W. B. Hislop, Edinburgh; Mr. J. D. Imrie, City Chamberlain, Edinburgh; the Right Hon. Thomas Johnston, Secretary of State for Scotland; Mr. D. K. Kevan, secretary, Ministry of Supply (Timber Control), Edinburgh; Dr. Robert Kirk, Kitchener School of Medicine, Khartoum; Mr. C. C. Learmonth, secretary, Merchant Company, Edinburgh; Prof. C. H. Lobban, professor of civil engineering, King's College, University of London; Mr. Robert Lyon, principal, Edinburgh College of Art; Mr. W. W. McClelland, executive officer to the National Committee for the Training of Teachers; Mr. G. MacKenzie, general manager, British Linen Bank, Edinburgh; Colonel G. H. G. McLean, Glasgow; Mr. Duncan Macnaughton, Edinburgh; Dr. G. C. McVittie, King's College, University of London; Dr. D. M. Morison, Royal Hospital for Sick Children, Edinburgh; Dr. Charles Ockrent, Glasgow; Prof. J. M. Robertson, Gardiner professor of chemistry, University of Glasgow; Prof. W. M. Smart, regius professor of astronomy, University of Glasgow; Dr. W. J. Stuart, consulting surgeon, Royal Infirmary of Edinburgh; Mr. J. M. Thomson, secretary, Scottish Education Department; Dr. E. Warhurst, Heriot-Watt College, Edinburgh; Dr. T. S. Westoll, Department of Geology, University of Aberdeen; Dr. R. W. Wheldon, Department of Agriculture, University of Durham; Mr. H. H. Wood, Department of English Literature, University of Edinburgh.

Announcements

THE Council of the Royal Society of Edinburgh has awarded the Makdougall-Brisbane Prize for the period 1938–1942 to Sir William Wright Smith, regius professor of botany in the University of Edinburgh, for his papers within the period of the award, and in recognition of his valuable contributions to systematic botany.

DR. LESLIE H. LAMPITT, chief chemist and a director of Messrs. J. Lyons and Co., Ltd., has been awarded the Society of Chemical Industry's Medal, which is given for conspicuous services to the Society. Dr. Lampitt has served on the Council of the Society for many years and has been its honorary foreign secretary and is now its honorary treasurer. He is also chairman of the Chemical Council. He has published many papers on foodstuffs research.

IT was announced in the House of Commons on February 24 that the Secretary of State for the Colonies has appointed Prof. A. M. Carr-Saunders, director of the London School of Economics, Sir Hubert Henderson, research fellow in economics, All Souls College, Oxford, and Sir John Caulcutt, chairman of Barclays Bank (Dominion, Colonial and Overseas), to the Colonial Research Committee (see NATURE, July 4 and 11, 1942, pp. 17 and 51).

THE Council of the Institution of Naval Architects has awarded the Gold Medal of the Institution for the year 1942 to Mr. W. C. S. Wigley, for his paper "Calculated and Measured Wave Resistance of a Series of Forms Defined Algebraically, the Prismatic Coefficient and Angle of Entrance being Varied Independently". The Wakeham Prize for 1942 has been awarded to Mr. N. Hancock, for his paper "Blade Thickness of Wide-Bladed Propellers".

DR. ALASTAIR FRAZER, reader in pharmacology, has been appointed to the newly created chair of pharmacology in the University of Birmingham.

THE Coopers Hill War Memorial Prize and Medal, founded by members of the Royal Indian Engineering College, Coopers Hill, in commemoration of members of the College who fell during the War of 1914–18, is awarded annually by the Institution of Civil Engineers and triennially in turn by the Institution of Electrical Engineers, the School of Military Engineering, Chatham, and the School of Forestry, Oxford. The triennial award falls this year to the Council of the Institution of Electrical Engineers, which has decided to invite members to submit for consideration a paper on any subject coming within the scope of electrical science or electrical engineering and their applications. Only corporate members of the Institution less than thirty-five years of age on January 1, 1943, are eligible. Papers submitted must be specially written for the purpose of the competition and reach the Secretary of the Institution not later than September 1.

APPLICATIONS, which must be received not later than April 15, are invited for the following scholarships awarded by the Council of the Institution of Electrical Engineers. *Duddell Scholarship* (value £150 per annum, tenable for three years), open to British subjects who have passed the matriculation examination of a British university and wish to take up a whole-time day course in electrical engineering; *Silvanus Thompson Scholarship* (value £100 per annum and tuition fees, tenable for two years), for works employees who are British subjects and have served a minimum apprenticeship of three years at an approved electrical engineering works. In consequence of the present regulations of the Ministry of Labour and National Service, these awards can only be made to candidates who were born on or after January 1, 1925, and who could complete a degree course by the end of December 1945. Particulars can be obtained from the secretary of the Institution, Savoy Place, London, W.C.2.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Mitotic Activity of the Mouse Parathyroid Gland

During the course of an investigation upon the cytology of the parathyroid gland of the mouse, it was observed that in immature animals the cellular differentiation characteristic of the adult did not commence until about fourteen days after birth. It was suggested[1] that this stage might (1) mark the beginning of a period of increased mitotic activity associated with differentiation, and (2) be correlated with weaning, which is normally accomplished by the third week. The preliminary data reported here appear to support these suggestions.

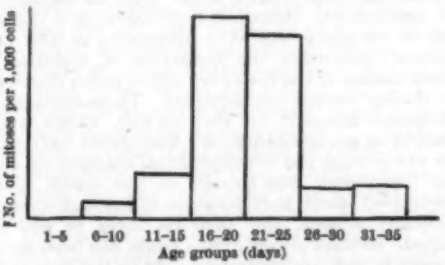
Immature and adult mice of various ages and both sexes were injected subcutaneously with colchicine. The adult animals received 0·1 mgm. in 0·25 c.c. of distilled water, and the immature a dose in proportion to their body weights, 30 gm. being taken as a standard for an adult. After 9·5 hr. both glands were removed, together with the thyroid, larynx and part of the œsophagus, and immediately fixed. Serial sections were cut in the sagittal plane, and so far as possible both glands were studied, except in certain instances, where this was prevented by the involvement of one of the parathyroids with thymic tissue.

The results were obtained from an examination of five 5-μ serial sections from the area of largest cross-section, and the increased mitotic frequency in the cells of the epithelium of the œsophagus was used as an index of the efficacy of the injection. In all instances the injections were effective.

The following data, in the form of an average for each of five serial sections, were obtained for every gland: (1) the number of mitoses per section (m); (2) the area (a) of the section measured in terms of the unit squares of a micrometer eyepiece at a magnification of ×350; and (3) the number of cells (n) per unit square at a magnification of about ×700, five readings being taken for each section. The mitotic frequencies were standardized by calculating the values of $\frac{m}{4.a.n} \times 1{,}000$, which gives the approximate number of mitoses per 1,000 cells. The average results for various ages are shown in the table. For the purpose of the graphic representation of the mitotic activity at various ages, the mean values of $\frac{m}{4.a.n} \times 1{,}000$ for five-day age groups were obtained.

Age (days)	Av. wt. (gm.)	No. of glands studied	Av. size of section (a)	Av. cell frequency (n)	Av. for $a \times n$	Av. mitoses per section (m)	$\frac{m}{4.a.n} \times 1{,}000$ = number of mitoses per 1,000 cells
6	2·8	3	13·6	6·3	85·7	0·26	0·75
* 7	4·5	1	44·9	6·2	278·4	0·8	0·75
* 9	5·0	2	32·5	6·7	217·8	0·4	0·5
15	8·0	4	19·5	5·9	114·6	0·8	1·7
16	6·0	3	43·0	6·2	266·6	9·8	9·2
18	9·0	2	50·3	6·3	318·4	7·8	7·3
20	9·4	3	41·9	6·2	259·8	5·8	5·6
21	9·5	3	40·8	6·4	261·1	6·4	6·7
26	13·0	5	44·0	6·5	286·0	1·2	1·0
33	20·0	4	57·0	6·2	353·4	1·6	1·1
90+	30·0	4	68·2	6·0	409·2	0·2	0·1

* It will be noted that these glands were unusually large, as also were they precociously differentiated. In this case their low mitotic frequency suggests that their true position is after the peak values of the 16–20 day age groups.



It will be seen from the diagram that there is a sharp and marked increase in the absolute mitotic frequency beginning at and extending through approximately the third week after birth. During this same period previous work has shown that the gland has passed from a state of cytological uniformity to one practically indistinguishable from the adult in the diversity of its cells and, judging by cytological criteria, from a condition of relative physiological inactivity to one of activity. In addition, it will be observed that this intensification of mitotic activity occurs during the latter part of the suckling period.

It is suggested that these observations might perhaps be explained on the assumption that a lowering of calcium intake through the milk towards the time of weaning stimulates the differentiation and activity of the gland. Horning's observation[2], that a decrease in the inorganic salt content of the alveoli of the lactating mammary gland of the mouse becomes noticeable at the 9–11th day of lactation, may have some bearing on this suggestion. So also may the observation of Morgan[3], that the dark principal cells of the adult human gland first appear at about six months of age; since in the mouse also, similar dark secretory cells first appear in significant numbers at a comparable time—that is, towards the end of the suckling period.

In conclusion, I would like to thank Dr. J. H. Woodger and Prof. Samson Wright for their advice and criticism.

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Feb. 2.

[1] Foster, C. L., *J. Endocrinol.* (1943, in the press).
[2] Horning, E. S., "Cytology and Cell Physiology", edited by G. Bourne (Oxford, 1942), p. 177.
[3] Morgan, J. R. E., *Archives Path.*, **21**, 10 (1936).

Group *N* Streptococci

THE question of the identity of *Streptococcus lactis*, important in milk and dairy products, has for many years interested bacteriologists. Many are convinced that it is identical with, or a mere variety of, *Str. faecalis*. With the advent of the Lancefield technique, it has been possible to differentiate into well-defined serological groups certain types of streptococci, and Groups *A* to *M* have been thus defined. *Str. faecalis* falls into Group *D* of Lancefield.

In 1936[1] we prepared group specific sera for *Str. lactis* and found that serologically it was quite distinct from *Str. faecalis*. We have now been able to complete this work and to show that *Str. lactis* is a member of a new group, to which *Str. cremoris* also belongs, which we propose to call Group *N*.

Recently Sherman, Smiley and Niven[2] and Seeleman and Nottbohm[3] have also established the serological identity of *Str. lactis*, and the latter authors attached to it the group letter *L*. But letters *L* and *M* have already been assigned by Fry[4] to streptococci isolated from dogs. Since we appear to have been the first to prepare specific group sera for *Str. lactis* we may perhaps claim the right to propose the group letter *N*. It would be unfortunate if confusion in nomenclature should invade the serological groups of the streptococci. We have therefore directed attention to the present position, which no doubt may be attributed to the lack of contact between workers engendered by the War.

The results of our work, which deals more fully with the organisms falling into Group *D* in their relationship to Group *N*, will be published shortly.

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Feb. 11.

[1] Rep. Nat. Inst. Res. Dairy., Reading, 37 (1937).
[2] Sherman, J. M., Smiley, K. L., and Niven, C. F., *J. Dairy Sci.*, **23**, 529 (1940).
[3] Seeleman, M., and Nottbohm, H., *Zbl. Bakt. I. Orig.*, **146**, 142 (1940).
[4] Fry, R. M. Paper read at meeting of Pathological Section of Royal Society of Medicine, December 6 (1938).

Auxin Production during Development of the Grain in Cereals

IT has been shown by Hatcher and Gregory[1] that auxin accumulates in the developing rye grain from the third week after anthesis, but almost entirely disappears as the grain ripens. These experiments were continued in 1942 to extend our knowledge of the auxin relations of the grain. The results here briefly discussed will be presented in detail elsewhere.

Avery, Berger and Shalucha[2] found that the yield of auxin from dry maize grains is increased tenfold by extracting in an alkaline medium of *p*H 10. Using the same technique with rye, twenty times as much auxin was obtained as with water. It was evident that the dry grain contains only a small amount of auxin but a large amount of an inactive substance from which auxin is formed by heating in alkaline solution. In 1942 both methods of extraction, with and without alkaline hydrolysis, were systematically compared, and no differences in extracted auxin were obtained until after the attainment by the grain of maximum auxin content. The appearance of the inactive substance is thus concurrent with the disappearance of the auxin, and there is little doubt that the one is formed from the other. The inactive substance in rye can scarcely be a precursor of auxin, but is rather an auxin derivative. Isolating the grain was found not to prevent auxin disappearance, as would be the case were auxin normally translocated away from the grain, and this is additional evidence of its inactivation *in situ*.

In maize, however, the situation seems to be quite different. Avery, Berger and Shalucha[2] determined the auxin content of maize grains at certain stages in their development and found that there is always an overwhelming predominance of inactive substance over free auxin, indeed as much as 97 per cent of their total at the stage of maximum auxin content. At the same stage in rye there is no inactive substance, and this difference between the two cereals is noteworthy.

In an attempt to locate the site of auxin formation in rye the whole ear was analysed. The results show that auxin first appears in the ear as it emerges, but is confined to the green anthers. This auxin disappears as the anthers ripen, but unlike that of the grain cannot be recovered by alkaline hydrolysis. Subsequent to anthesis no auxin was found except in the carpel, suggesting that it is formed *in situ*. More precise location of the auxin was made by extracting separately the excised embryos, the aleurone and the endosperm. This revealed that the auxin is absent from the embryo, and is confined mainly to the aleurone layer. Further it was found, by extracting transverse sections of the whole grain, that the auxin is much more concentrated at the embryo end. It may thus be concluded that the auxin is formed inside the grain, in the aleurone region near the embryo.

There is evidence to show that the auxin in the rye grain, which accumulates relatively late in development, is not derived by translocation to the ear since premature harvesting in no way interferes with auxin production. That auxin is not produced directly from the products of assimilation is shown by the fact that accumulation proceeds in ears kept in total darkness from a stage prior to its normal first appearance. Accumulation begins at a definite stage in ontogeny, and it is interesting to note that Nutman[4] postulates the formation of hormone in certain tissues of the rye ovary which suffer degeneration during normal development. These include the endosperm adjacent to the embryo, which is the region of auxin accumulation. Premature harvesting does not curtail the developmental changes, as Nutman[5] has shown, but though in the dwarf grains so produced starch accumulation in the endosperm is practically absent, the aleurone layer is well developed. In these dwarf grains auxin has been shown to occur in high concentration. As to the immediate source of the auxin, I am inclined to the view that it is derived from the cytoplasm of the disintegrating cells, and though the auxin of the rye grain has not yet been identified, it may prove to be indole-3-acetic acid, as in maize[6].

The ear of rye is thus characterized by two separate systems of auxin production, one in the developing anther, the other in the developing carpel. In both systems auxin first accumulates and then disappears, but whereas in the carpel an inactive derivative is formed from which auxin can be recovered by alkaline hydrolysis, in the case of the anther there is no evidence of the same reversibility.

On the results of these experiments the inactive substance of the rye grain cannot be considered as an auxin precursor; it is merely a modification of auxin and derived from it.

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Feb. 15.

[1] Hatcher, E. S. J., and Gregory, F. G., NATURE, 148, 623 (1941).
[2] Avery, G. S., jun., Berger, J., and Shalucha, B., *Amer. J. Bot.*, 28, 596 (1941).
[3] Avery, G. S., jun., Berger, J., and Shalucha, B., *Amer. J. Bot.*, 29, 765 (1942).
[4] Nutman, P. S., *Ann. Bot.*, N.S., 3, 731 (1939).
[5] Nutman, P. S., *Ann. Bot.*, N.S., 5, 353 (1941).
[6] Haagen-Smit, A. J., Leech, W. D., and Bergren, W. R., *Amer. J. Bot.*, 29, 598 (1942).

Vitamins in Rose Hips

THE prominence now being given to rose hips as a source of vitamin C has tended to obscure their value as a source of other vitamins. Svensson[1] reported in 1936 that different species of Scandinavian rose hips formed a rich source of vitamin A, since they contained carotene equivalent to 6,000 to 10,000 I.U. of vitamin A per 100 gm. We have found British hips also to be a rich source of vitamin A. Using dried extracts prepared in these laboratories from several tons of ripe hips, mainly *R. canina* and *R. dumetorum*, collected in this area last autumn, we have found carotene contents equivalent to about 6,000 I.U. of vitamin A per 100 gm. Tests on samples of several other species kindly provided by Dr. Melville gave similar results, and the conclusion may be drawn that British rose hips have a vitamin A value similar to that of carrots. The carotene estimations were made by an unpublished method, of which Dr. T. Moore and Dr. Vernon Booth kindly gave us details.

These dried extracts were prepared with the object of obtaining a stable potent source of vitamin C. The vitamin C content ranged from 1,300 mgm. to 1,500 mgm. per 100 gm., indicating them to be one of the richest sources of the natural vitamin C so far available in Great Britain, although still more potent dried preparations have been obtained in Germany by Sabalitschka and Priem[2] using species of rose hips containing more vitamin C. Storage experiments on these dried extracts at different temperatures indicate that they form a stable source of the vitamin, the loss of vitamin C in 6 months at normal temperatures being negligible. It has been shown by a number of workers[3,4] that in rose hip syrup and black currant purée stored for six months at normal temperatures the loss of vitamin C may be as high as 50 per cent. Such a period of storage may easily occur between the preparation of the syrup or purée and its consumption.

Rose hips have recently been reported by Bacharach and Coates[5] to contain significant amounts of vitamin P (about 7 G.L. units per gm.). These workers have kindly determined the vitamin P in one of our dried extracts, and obtained the remarkably high figure of 520 G.L. units per gm., indicating that the extract is more than five times as active as purified hesperidin, and more than seventy times as active as fresh rose hips. From the method of preparing the dried extract we should have expected it to contain six or seven times as much vitamin P as the fresh rose hips, or 40–50 G.L. units per gm. instead of the 520 G.L. units per gm. found by Bacharach and Coates. This discrepancy may be due to two causes: (1) our rose hips containing more than ten times as much vitamin P as the hips examined by Bacharach and Coates; (2) loss of vitamin P in Bacharach and Coates's hips before they were tested. In regard to (1), Bacharach and Coates found no significant difference in the vitamin P content of two species of rose hips, *R. arvensis* and *R. coriifolia*, one of which contained much more vitamin C, and the other much less than was present in the rose hips used in making our extracts. If the discrepancy is due to (1), there must be a variation in the vitamin P content of different samples of rose hips as wide as that found for vitamin C, but not necessarily running parallel with it. In regard to (2), it should be stated that our extracts were made with special precautions to avoid destruction of vitamin C by the oxidizing enzymes present in the fresh hips, and the high vitamin C content of our dried extract indicated that our precautions had been successful. It may be that in so doing we also avoided loss of vitamin P.

We have confirmed the finding of Pyke[6] that rose hips do not contain a significant amount of vitamin B_1.

Full details of our investigations will be published later.

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Feb. 17.

[1] *Skand. Arch. Physiol.*, 73, 237 (1936).
[2] *Ernährung*, 6, 134 (1941).
[3] *Quart. J. Pharm. Pharmacol.*, 15, 314 (1942).
[4] *Brit. Med. J.*, 1, 559 (1942), and private communication.
[5] *Analyst*, 67, 313 (1942).
[6] *Biochem. J.*, 34, 330 (1940).

Vernalization of Lettuce

THERE has recently come to hand a report[1] on the vernalization of two varieties of lettuce. The plants obtained from seed which had been germinated and given 28, 42 and 56 days treatment at 4° C. all produced flowering stalks 14–20 days earlier than the control.

Similar results have been obtained with the cabbage type variety "Ideal" in experiments carried out at this Institute during 1942. It was found that when moistened seed was kept at 2–8° C. for 16 days the plants from them formed flowering stalks 20 days earlier than the controls, and were ready for harvesting for seed 26 days ahead of the controls. The date of hearting was not affected by vernalization, but the plants from vernalized seed remained in the hearted condition only 4–5 days, compared with approximately 26 days for the control. This had the important effect of reducing by about 50 per cent the loss of plants due to soft rot, Botrytis spp., which develops rapidly while the plants are compact on the ground.

Vernalization of lettuce is clearly of no value to the producer of lettuce plants for sale, but may be of

considerable value in seed production where the reduced time taken to run to seed can mean the saving of a crop. The reduction of loss from Botrytis and the added facilities for selecting non-bolting types, that is, those plants that do not respond to vernalization, could also prove useful.

This marked response of the lettuce to cold treatment makes it a useful subject for experimental work.

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Feb. 13.

[1] Gray, S. G., *J. Council Sci. Ind. Res.*, Australia, **15**, 3 (1942).

Nature of Peptones

THE result of the cleavage of several proteins or their derivatives by pure proteinases has been investigated by us. This was accomplished by the determination of the ratio of the total nitrogen contained in such linkages as might be split by proteinases to the amount of nitrogen contained in the terminal (NH_2 + NH)-groups set free by hydrolysis. (This ratio will amount to 6 in the case of a hexapeptide, in a tetrapeptid to 4, etc.) The substrates thus investigated were casein-peptone RWI[1] (prepared from casein-Hammarsten), a fraction of the anhydrolytic breakdown obtained from edestin (Fr.E[2]), and in addition ovalbumin.

The procedure was as follows. The proteins were subjected to a preliminary cleavage by a pure proteinase (casein and ovalbumin to pepsin-hydrochloride, the edestine product to pure pancreatic proteinase). The peptone formed was isolated and its hexone bases and tryptophane were determined quantitatively, and similarly the total nitrogen, the nitrogen of the amido groups (–$CONH_2$) and the nitrogen contained in (NH_2 + NH)-groups, the latter estimated by Linderstrøm-Lang's titration method.

In addition, the maximum amount of cleavage to which the peptone was still liable by successive splitting with pure proteinases was determined. From the total nitrogen must be deducted those amounts of nitrogen which *a priori* are not concerned in the action of pure proteinases, that is, the amount corresponding to 3 nitrogens of the guanidine radical of the arginine, to 2 nitrogens belonging to the imidazol radical of the histidine, to one nitrogen deriving from the ε-group of the lysine, to one nitrogen of the indol radical of the tryptophane, and finally, to the amount of nitrogen contained in the amido groups.

On the other hand, from the values obtained by the titration of the (NH_2 + NH)-group must be deducted that amount of nitrogen which reacts by this method without, however, being concerned in the enzyme action mentioned above, namely, that corresponding to one nitrogen belonging to the imidazol radical of histidine, to the guanidine radical of arginine, and to the ε-group of the lysine respectively. To this last 'corrected' value is added the amount of nitrogen contained in the –CO–NH-linkages which were opened by the additional splitting with proteinase, as determined by the enzyme tests. This value represents the total nitrogen contained in peptide-linkages opened hydrolytically by pure proteinases. If now the value for the total nitrogen (corrected as described above) is divided by this latter value, their quotient will represent the ratio $\frac{\text{N, total cleavable}}{\text{N, split hydrolytically}}$. This ratio in the peptones from casein and edestin amounted practically to 4. In the albumin-peptone, provided the latter is split exhaustively either by pepsin-hydrochloride or pancreatic proteinase, this ratio also amounted to 4. But if this peptone, having been previously split exhaustively by pepsin-hydrochloride in the enzyme tests, was subjected to the exhaustive action of pure pancreatic proteinase, an additional amount of cleavage was obtained, so that this value was reduced to nearly 3.

It appears, therefore, that the exhaustive digestion of casein, ovalbumin-pepsin-peptone (the latter by pepsin only), and the edestin product, so far as affected by pure proteinases, yields peptones which represent mixtures of tetrapeptide-chains, whereas the pepsin-peptone obtained from ovalbumin, which has been subjected to additional splitting by pancreatic proteinase, yields still lower peptide chains, for reasons which must still be investigated.

A full report on this investigation will be given elsewhere.

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S. KUK.
J. DIAMANTE-LICHTENSTEIN.

Department of Biochemistry
and Colloidal Chemistry,
Hebrew University,
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Jan. 22.

[1] Kuk, S., *Enzymol.*, **6**, 194 (1938).
[2] Fodor, A., and Lichtenstein, N., *Enzymol.*, **1**, 311 (1939).

Mode of Action of Ionizing Radiations on Aqueous Solutions

VARIOUS authors[1,2,3] have reported that the action of ionizing radiations in aqueous solutions is indirect. The primary action appears to be on the water, with the formation of an intermediate product which then acts upon the solute. If one accepts this hypothesis, one would expect: (1) that with an equal dose of radiation a dilute solution would be relatively more affected than a more concentrated one (dilution phenomenon); and (2) that any additional substance in the solution, capable of reacting with the intermediate product, would divert some of this from its partner to itself (protection phenomenon).

The indirect action theory has escaped general attention and even its supporters have only partially appreciated its logical consequences. As a result, experiments have frequently been interpreted in terms of the 'hit theory' without proper consideration of the possibility of an indirect action. One result of this situation is the common but erroneous belief that enzymes are too insensitive to radiation to account for radiation effects in living tissue.

One of us[4,5,6] has recently demonstrated that the effect of X-rays on aqueous solutions of enzymes and of other biologically active substances depends on the concentration and purity of such solutions, and that doses of as little as 50 roentgens can produce marked effects when concentrations of the order of those occurring in living cells are irradiated.

It is possible to show conclusively, from the effect of the initial concentration in these recent results, that the action of the radiation on the solutes used

was through the medium of an intermediate product. Experiments using a wide range of concentrations of carboxypeptidase showed that *the proportion of the molecules inactivated was determined by the ratio of the dose to the initial concentration*, and that it increased as the ratio increased.

This may be written:

$$\frac{y}{y_0} = f\left(\frac{D}{y_0}\right). \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where y is concentration of active molecules after a dose of D roentgens, and y_0 is concentration of active molecules initially.

The substantial accuracy of this formula is demonstrated by the accompanying diagram, in which points with the co-ordinates $(D/z_0, z/z_0)$ derived from the same experimental points as Figs. 1 to 4 in reference 4 lie closely on one curve although they apply to a 345-fold range of y_0 and to an 8,000-fold range of D. z and z_0 have been taken to be the 'activities' of the solution expressed in terms of 'enzyme units', and are therefore approximately proportional to the concentrations, since the ratio of activity to concentration varies relatively slightly over the whole range of concentrations used. Other experiments indicate that similar formulæ apply to many other substances.

By differentiating equation (1) with y_0 constant, we get an equation which can be converted to the form

$$dy = -F\left(\frac{y_0-y}{y}\right)dD. \quad . \quad . \quad . \quad . \quad (2)$$

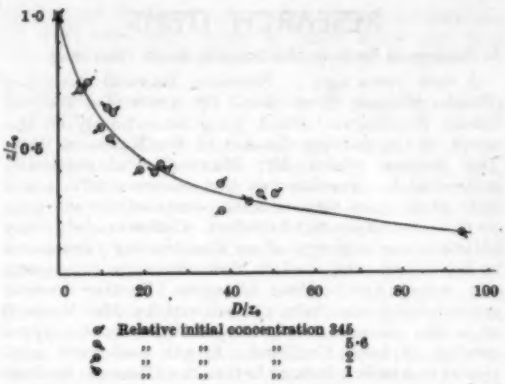
Thus we see that, whatever the dose that has been delivered, the proportion of the energy provided by a small extra dose, which is expended in inactivating further enzyme molecules depends only on the relative numbers of the molecules still active and those already inactivated.

To explain this phenomenon we must postulate that the energy absorbed from the radiation forms a quantized intermediate product—perhaps 'activated water'[1,7] or some similar concept—which distributes this energy between the active and inactive enzyme molecules, inactivating the former. In the case of certain simple compounds, $F\left(\frac{y_0-y}{y}\right)$ is constant, which means that the intermediate substance reacts with the unaffected molecules only. The variability of $F\left(\frac{y_0-y}{y}\right)$ as demonstrated by the curvature in the diagram may be said to be due to a 'self-protective' effect, since the inactivated molecules retain their power to react with the intermediate product.

The formula

$$dy = -\frac{CydD}{y-n(y_0-y)} \quad . \quad . \quad . \quad . \quad (3)$$

which is a special case of equation 2, and in which C and n are constants, is of a form flexible enough to cover both the findings on the action of X-rays on pure enzymes and other biological substances, and the results of other workers on biologically inactive substances; n is the relative affinity of the inactivated molecules for the intermediate product. Any value of n of the order of unity fits the points in the diagram quite closely. If only the active molecules can react with the intermediate product, $N = 0$, and the number of molecules inactivated is proportional to the dose until there are no active molecules left. $N = 1$ would give $y = y_0 e^{-CD/y_0}$, which is similar to the formula derived on the simple 'hit theory', the only difference being that it corresponds to the size of each target being not fixed but inversely proportional to the initial concentration. We may point out that only by means of experiments using a range of initial concentrations can one deduce the existence of an intermediate product in the action of X-rays; if only one concentration had been used, the curve in the diagram might well have been taken as an indication that the 'hit theory' applied.



The conception of an intermediate radiation product simultaneously explains the phenomenon of 'protection', namely, that irradiation produces a smaller effect when other solutes are present, which is very difficult to explain on the basis of direct action. The amounts of added substance which produce the effect are too small to absorb the radiation directly to any appreciable extent, while the effect cannot be due to the formation of a loose compound which is comparatively insensitive to the inactivating agent, for the diversity of the protecting substances rules out this possibility. In fact, 'protection' by added substances is another manifestation of the phenomenon which accounts for the curvature in the diagram. Like the inactivated molecules of the main solute, the molecules of the added substance take a share of the radiation product and thus the number of molecules of the main solute inactivated is reduced.

It is thus apparent that the hypothesis of an intermediate product formed by the action of the radiation on the water is essential to account for all the results.

We have deliberately not been specific as to the nature of this product or the mode of its action. There is the possibility, which we do not exclude, that this chemically active product may be charged and act physico-chemically in the case of colloids.

W. M. DALE.
W. J. MEREDITH.
M. C. K. TWEEDIE.

Christie Hospital and
Holt Radium Institute,
Manchester.
Feb. 2.

[1] Fricke, H., Cold Spring Harb. Sympos., **2**, 241 (1934).
[2] Hopwood, F. L., *Brit. J. Rad.*, **13**, 221 (1940).
[3] Luria, S. E., and Exner, F. M., *Proc. Nat. Acad. Sci.*, **27**, 370 (1941).
[4] Dale, W. M., *Biochem. J.*, **34**, 1367 (1940).
[5] Dale, W. M., *Biochem. J.*, **36**, 80 (1942).
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RESEARCH ITEMS

Archæological Finds in the Scottish South West Isles

A FEW years ago, J. Harrison Maxwell described (*Trans. Glasgow Arch. Soc.*, **10**) a vitrified fort on Eilean Buidhe, an island lying immediately to the north of the narrow channel in the Kyles of Bute. The feature which Mr. Maxwell was especially interested to examine was the existence of a tower base at each of the cardinal points of the compass on the circumference of the fort. Unfortunately, very little further evidence of an illuminating kind seems to have been obtained at this obviously interesting site, which lies so near Glasgow. Further investigations have also been carried out by Mr. Maxwell at a site on an island, Eilean Righ, in the upper reaches of Loch Craignish, Argyll, and were mentioned in a recent lecture before the Glasgow Archæological Society. The island yielded an Early Iron Age fort of normal structure. But another hut circle inside a larger enclosure was the object of Mr. Maxwell's attention. It lies almost due west of the jetty. The inner circle measured 25 ft. × 28 ft., the outer enclosure some 80 ft. × 49 ft., the wall being about 5 ft. thick. Mr. Maxwell suggests that it was a prehistoric shrine of the moon god, and he amends the name of the island from Righ to Re, which in Gaelic means moon. He gives, however, an alternative suggestion that the structure is the remains of a cashel —one of those early ecclesiastical establishments which were built by the Irish monks. Other sites in the Loch Craignish district were also studied, notably a fine though dilapidated round-chambered cairn of the Early Bronze Age at the northern end of the Loch.

Prehistory of North America

"ARCHÆOLOGICAL and Geological Investigations in the San Jon District, Eastern New Mexico" (*Smithsonian Mis. Coll.*, **103**, No. 4) is by F. H. Roberts. Like similar investigations which have appeared from time to time under the auspices of the Smithsonian Institution, this work is of local interest. All the same, the comprehensive picture of the prehistory of North America will only become possible as a result of quantities of such local studies. While it appears in this case that the later levels of the excavations are to be associated with Indian groups, it is claimed that the earliest level, which yielded a sort of Yuma point, contained bones of extinct species of bison and mammoth. The antiquity of the earliest stone age in America is still *sub judice* and, too, the date when any one species of animal became extinct is not necessarily the same in different parts of the world. At the same time, evidence does seem to be accumulating to show that some of the earliest American stone industries may be older than has hitherto been thought probable.

American Land and Freshwater Isopods

A SECOND supplement to William G. Van Name's useful work "American Land and Fresh Water Isopod Crustacea" (1936) is now published by the author (*Bull. Amer. Mus. Nat. Hist.*, **80**, Art. VIII, 299–329; 1942). This covers additional species and the more important new information about previously included species that has been published since the first supplement to that work came out in 1940. Four new species are described and twenty-nine species are added to the list of American land and freshwater forms given previously. The species of some of the aquatic freshwater isopods are very difficult to distinguish. It is found that in the Asellota the characters of the male pleopods are the most reliable, as already used by Dudich, Tattersall and Racovitza. The interesting genus Cæcidotea is specially considered. Many of these are large, *C. acuticarpa* reaching a length of 20 mm.; some have no eyes, or the eyes are very much reduced, their habitat being springs, wells and caves. *Janiropsis exul* is a member of the otherwise exclusively marine family Janiridæ. It differs, however, from Sars' Janiropsis, in which it is placed provisionally, in certain features of the male, notably in the relatively enormous development of the long anterior process of the second pleopods and in the conspicuously widened posterior portion of the body. The figures given in this supplement are excellent and very helpful, being in a good clear outline.

Salmon of the River Erne

MR. ARTHUR E. J. WENT, continuing his researches on Irish salmon, publishes a short paper dealing with the scales and lengths of the fish, mainly in 1928 ("Results of the Examination of a Small Collection of Scales and Data". *Sci. Proc. Royal Dublin Soc.*, **22** (N.S.), No. 49; 1942). Ninety-two per cent of the fish had migrated as two-year smolts whereas the remainder were one- to three-year smolts. Almost eighty-four per cent were maiden summer fish. The small summer fish having relatively high average weights are the most important commercially, as they are approximately one sixth heavier than the grilse, the next heaviest age group. The faster growing fish migrated first. As in the River Shannon, the smolts could be divided into two groups depending on whether or not the fish had made growth in fresh water in the spring prior to migration as a smolt. Type *A* smolts of any smolt class have a greater mean length at the end of every year of life than Type *B* smolts of the same smolt class. In the sea the large spring fish had a greater average growth-rate than any other age group.

Giant Fibres in Crustacea

IT has been known for some time that while myelinated nerve fibres are rare in invertebrates in general they do occur in some crustacea. William Holmes (*Phil. Trans. Roy. Soc.*, B, No. 582; 1942) has studied the giant myelinated fibres in the prawn, *Leander serratus*. It is found that the median and the lateral giant fibres in the central nervous system are formed by the fusion of the processes of many segmented nerve cells. A previous writer claimed to have found a new type of synaptic relation in the prawn, shrimp and crayfish, but the present investigation gave no support to this, and indeed it was found that there was always complete discontinuity in the axioplasm. Two quite different types of synapses are described; in one the individual neuroplasms in a giant fibre while running side by side are nevertheless separated by a myelin layer over by far the greater part of their course, but they do appear to come into actual contact over a length of not more than 10 μ. In the other type a myelinated fibre has contact with a non-myelinated fibre by means of a number of fine axonic processes, which perforate the myelin sheath. Some of the myelinated fibres may have a total diameter of 60 μ in the central nervous system and 90 μ peripherally, so that they are noticeably larger than those that have been described for any vertebrate.

Evolution in Plants by Kaleidoscopic Mutation

ARGUMENTS have recently been put forward by Willis in support of his claim that the course of evolution has been from family through genus to species, and not vice versa as is required by the selection theory. This progress was achieved by mutations that might apparently be of any rank. It is now pointed out (*Proc. Roy. Soc.*, B, **863**, 161; December 1942) that where in any flora, as in that of Ceylon for which specific instances are given, a genus is represented by two species only, one of which is endemic to that area and the other more widely distributed, the characters differentiating the two are commonly very clearly marked and not infrequently are such as mark the division of the genus into sections or even subgenera. But the endemic species in such cases has almost always arisen from the other, and hence its characters are received from an ancestor in which they are not shown but which must have been carrying both characters of the contrasted pairs. As the occurrence of genera or species showing some character opposed to that in the family as a whole is a very common phenomenon, it is concluded that any member of a family carries in itself all the possible characters of that family, and that evolution takes place by mutations proceeding in a manner which is compared with the action of a kaleidoscope.

'Take-all' Disease of Wheat and Associated Fungi

THE fungus *Ophiobolus graminis*, causing 'take-all' disease in wheat, is now shown by S. D. Garrett (*Ann. Appl. Biol.*, **28**, 4, 325; Nov. 1941) to persist from year to year on the roots of several native grasses commonly used for the production of temporary leys. Survival of the parasite is, however, negligible on fallow ground and under clover. *Phleum pratense* is resistant to the fungus, and it is suggested that this grass, with *Avena elatior* instead of Lolium spp., should be used with clovers for seed mixtures on heavily-infected land. The fungus *Fusarium culmorum* is often pathogenically associated with *O. graminis*, and Alan G. Walker has studied the colonization of buried wheat straw by this secondary fungus (*Ann. Appl. Biol.*, **28**, 4, 333; Nov. 1941). It was found that *F. culmorum* and Penicillium spp. were numerically the most important organisms developing on buried straw under the experimental conditions. *F. culmorum* had low resistance to mild sterilizing agents, but often grew more vigorously than the Penicillium spp. which were, however, more resistant to sterilization. These results indicate the probability of persistence of *F. culmorum* in the straw of ploughed stubble, and the possibility of its control, where necessary, by treating the stubble with a mild disinfectant.

Mutations in Gram

SEVERAL mutations have been found in *Cicer arietinum* by R. B. Ekboto (*Ind. J. Genet. and Plant Breed.*, **2**, 50; 1942). One mutation—tiny leaf—produces a compound bipinnate leaf with tiny leaflets and a bushy habit to the plant. It behaves as a recessive. Another mutation, simple leaved, converts the compound leaf into a simple one; this phenomenon has not been reported frequently in genetical literature. The mutation is liable to undergo the reverse change to normal, consequently strains of simple leaved plants do not breed true. Mutations of flower colour from pink to white and of seed coat from white to black have also been observed and their genetical behaviour analysed.

Electrical Detector of Condensation in High-Velocity Steam

A NEW method has been developed by A. M. Binnie and J. R. Green (*Proc. Roy. Soc.*, A, **181**, 134; 1942) for finding where condensation in a convergent-divergent steam nozzle commences. The resistance of a short length of fine wire, mounted on a rod and traversed axially through the nozzle, altered sharply at a point where there was a small sudden pressure rise and where an earlier investigation had shown that condensation of the supersaturated steam began. The mean temperature of the wire upstream from this point was found to be nearly the same as that of the steam at entrance to the nozzle. It was greatly in excess of the temperature of the high-velocity steam passing the wire. The wire was heated electrically and the Nusselt number of heat transfer to the steam was measured under the prevailing supersonic conditions. A comparison is given between the Wilson line, showing the position of condensation on the Mollier diagram, with that obtained for a different nozzle used in earlier work. The steam conditions at inlet were as important as the shape of the nozzle.

Dark Companion of 61 Cygni

IN a paper on "The Orbital Motion in the Visual Double Star 61 Cygni", read at the autumn general meeting of the American Philosophical Society during November 20–21, K. Aa. Strand said that extensive photographic observations of high accuracy taken at the Potsdam, Sproul and Lick Observatories have revealed perturbations in the orbital motion of the visual double star 61 Cygni which are caused by the existence of a third invisible member revolving around one of the two visual components. The only solution which will satisfy the observed motions gives the remarkably small mass of 1/60 that of the sun or sixteen times that of Jupiter. Considerably smaller than the smallest known stellar mass, the dark companion must have such an extremely low intrinsic luminosity that it may be considered a planet rather than a star; this would mean that planetary motion has been found for the first time outside the solar system. An extensive investigation of the motion in the large orbit is being carried out at the Sproul Observatory. Though not yet completed, a period of 720 years and a semi-axis major of 24·554″ represent closely the observed arc. For a parallax of 0·294″ these elements give a total mass of 1·120 for the system. The relative motion of the visual component with respect to the centre of mass of itself and the invisible component, *C*, has a period of 4·9 years and a semi-axis major of 0·020″. No decision can be made as to which of the two components *C* is attached. This is, however, of minor importance for the determination of the mass of *C*, because *A* and *B* are nearly equal in mass. Using the masses 0·580 and 0·550 as derived from Eddington's mass-luminosity curve, we obtain in either case: $M_C = 0{\cdot}0160$; hence *C* is rotating in an orbit with a semi-axis major of approximately 0·70″ or 2·4 astronomical units. On account of the large eccentricity ($e = 0{\cdot}7$) of its orbit, *C* is at periastron only 7/10 of an astronomical unit from its visible companion.

SAFETY IN MINES RESEARCH BOARD

ANNUAL REPORT

ALWAYS in the past a document of unusual interest, the twentieth annual report of the Safety in Mines Research Board fully maintains the standard of previous issues. Considerably slimmer than its predecessors, the report nevertheless clearly demonstrates the far-reaching importance of the Board's many avenues of research—all directed to the common end of saving life and limb in coal mines.

Coal Dust Explosions

Major disasters in British coal mining have almost invariably been associated with explosions of coal dust, and for many years it has been known that incombustible dusts, if present in sufficient proportion, were capable of suppressing such explosions. That no finality has been reached in the problem of eliminating coal dust explosions is shown by the report. Mechanized mining has inevitably resulted in an increase in the quantity of fine dust produced during mining operations, and under a grant from the Board, the British Colliery Owners' Research Association is carrying out investigations in the reduction and collection of dust in fully mechanized workings. Water sprays, working under a pressure of 120 lb. per sq. in., are being used as a means of reducing the amount of dust carried away by the air current during the loading of tubs. A similar method is being tested for the suppression of the dust made during coal-cutting operations with a machine adapted for over-cutting.

Investigations continue on the use of stone dust as a means of suppressing coal dust explosions. The results of one series of experiments serve to emphasize the importance of the stone dust and the coal dust being in intimate mixture. Incombustible dusts in contact with a humid atmosphere are subject to 'weathering', that is, the dust becomes less dispersable. Experiment shows that the lower the proportion of particles of less than 10 microns in diameter, the higher the dispersability; attempts have been made, with some success, to prepare dusts with an unusually small proportion of ultra-fine particles.

Electrical Research

The casing of flame-proof apparatus must be strong enough to withstand the pressure of an internal firedamp explosion. A useful item of information for manufacturers of such apparatus is that a static pressure is a true measure of the ability of a casing to resist an internal explosion. Hydraulic or pneumatic pressure can, therefore, be used to ascertain the factor of safety of the casings.

Mining Explosives

Further work on sheathed explosives confirms the value of the sheath of inert material as a means of preventing ignitions of firedamp when shotfiring. It is the general practice in Great Britain to fire shots singly, but many mining engineers hold the view that the wider application of simultaneous shotfiring would not only result in a great saving of time, but also increased safety. The objection to this method of shotfiring is the danger of undetected misfires, but the results of the Board's investigations on this subject are reassuring. In the pits of one colliery company, some 3,500 shots per month are being fired in series of five and six together. Practical results are reported as excellent, and in the course of a year, the sole miss-fire was due to a defective exploder.

Falls of Ground

In this all-important branch of the Board's activities, much work continues to be carried out both in the laboratory and underground. A major problem created by the War is that of maintaining a sufficient supply of supporting materials for the coal mines of Great Britain. Prior to the War, the bulk of the pitwood was imported—chiefly from the Baltic States and Russia; with shipping engaged on even more urgent tasks, every effort has to be made in providing substitute materials for support. Investigations have been carried out on the relative strengths of home-grown and imported timber, and the importance of seasoning is demonstrated by an experiment in a warm return airway. As a result of a short period of seasoning under these conditions, the strength of the timber was increased by 20 per cent.

With the object of conserving timber and steel, consideration has been given to the use of concrete underground. It would seem that the use of concrete supports at the working face has met with but a limited measure of success; concrete is apparently not well suited to the "repeated setting, loading and unloading", which is the lot of all face supports. Where concrete supports are used at the working face, particular attention must be given to the packing of the goaf, so as to reduce the convergence between roof and floor to the absolute minimum. To prevent premature failure some yielding device is necessary, or the props must be allowed to penetrate the floor. On roadways the use of concrete has proved to be more successful; concrete slabs have been used as struts between steel arches, and these remained unbroken although the arches were severely distorted.

Normally a task of major importance, the work on falls of ground and roof supports assumes a special significance under present conditions, and the report clearly indicates that the Board is playing a full part in investigating the use of new supporting materials and methods of support—research which is vitally necessary if supplies of steel and timber in Great Britain are to be conserved. H. HARTLEY.

FORESTRY IN TRINIDAD AND TOBAGO

THE Annual Report of the Conservator of Forests of Trinidad and Tobago for the year 1941 (Council Paper No. 25 of 1942. Govt. Printer, Trinidad, 1942) gives a brief summary of the present position of the general forest policy for the Colony. Reservation of forests except in the western portion of the Northern Range alluded to in former reviews of these reports is considered eminently satisfactory. Since forest reserves occupy 22 per cent of the total area of the Colony, Trinidad and Tobago may be regarded as setting an example of a high average to many other Colonies which are still far behind this standard.

In forest management as reflected by working plans the Colony is in an exceptional position. It is some years now since the head of the forestry administration set himself the task of drawing up preliminary

working plans for the forestry areas under his charge. His gazetted staff, though small, were well trained to undertake the work. The consequence is that in the present report the conservator can write, "Almost all the Forest Reserves are now governed by Working Plans, under which some form of elementary yield control has been introduced: owing to recent increase in sawmills and demand for local timber more intensive yield control will be required in some areas in the near future. So far as the improvement of the growing stock is concerned the silvicultural programme now provides for an average regeneration of approximately 550 acres per annum, whilst the total area of completed regeneration amounts to 3,958 acres. Further expansion of the rate of regeneration of indigenous species can be effected when the shortage of charcoal burners and labourers, caused by the U.S.A. bases, comes to an end."

With reference to the position of working plans in the Forest Department under the Colonial Office, it would place the actual position in a stronger light if some of the most detailed plans could be printed and circulated within the British Empire. The nature of the working plans themselves and their general drafting and proposals would thus be available to other departments and their forest officers. On the subject of utilization, for some years the exploitation of the mora forests, in which this species grows to some extent gregariously over about half the total area of forest in Trinidad, has been contemplated, but it is said that the difficulties of exploiting these areas have not yet been surmounted owing to an accumulation of checks caused by war conditions.

The utilization of both local and imported lumber is extremely wasteful, says the conservator, avoidable losses by fungus and termite attack, owing to lack of precautionary measures, being very high. The Colony is also still dependent on large supplies of imported softwoods, mainly pitch pine, white pine and Douglas fir, apart from the special demand created by war conditions. It may be asked whether this failure to open out the mora forests and to check wasteful exploitation may not be due to the smallness of the forest staff of the Colony, in view of the growing work under the Department.

LOCATION OF THUNDERSTORMS BY RADIO METHODS

MANY investigators in various parts of the world have used radio receiving equipment to study atmospheric disturbances, their wave-form, nature and origin. It is clear from this work that such atmospherics arise from electrical disturbances in the atmosphere, and mainly if not entirely from actual lightning flashes. The results of such investigations have been applied to some extent by the electrical engineer in connexion with the breakdown of overhead line power distribution systems. In Great Britain lightning is responsible for a large proportion of such breakdowns, and if means could be available to give adequate warning of the presence of a thunderstorm in a particular area, certain steps can be taken by operating engineers to reduce the probability and extent of interruptions of electrical supply. A contribution to this aspect of the subject has recently been provided in a paper entitled "The Determination of the Location and Frequency of Thunderstorms by a Radio Method" by Mr. J. S. Forrest, read before the Royal Meteorological Society on November 18 last.

Previous investigators had shown that there was some correlation between the field strength of atmospherics and the distance of the source, but further knowledge was required to put this on a sufficiently definite basis for practical use. Moreover, further investigations were required in order to ensure that the atmospheric disturbances recorded emanated from, or were at least uniquely associated with, lightning strokes to ground, which are the cause of breakdown of high-voltage electrical systems. The equipment used in the present work has been previously described by the author, and consists essentially of a mains-operated radio receiver tuned to approximately 150 kc./sec. (wave-length 2,000 m.), the output from which is applied to a commercial type moving-coil pen-recorder marking continuously on a paper chart. Provision is made for maintaining the overall sensitivity of the receiver constant, so that it can be operated twenty-four hours a day for months at a time. An ordinary outdoor aerial is used of length about 20 m., and it was found that a full-scale deflexion on the recorder chart corresponded to a peak field-strength of between one and two millivolts per metre, indicating the presence of a thunderstorm within 16 km. of the instrument.

The present paper gives the results of three years experience with this technique. The first equipment was installed at a station in Surrey in 1939, and other instruments have been brought into use in Wiltshire and Northumberland; and all three are now in continuous operation. Samples of the charts showing thunderstorm records accompany Mr. Forrest's paper, and the times of occurrence of overhead line breakdowns are shown thereon, to illustrate the correlation between the distance of a storm and the recorded atmospherics resulting from it.

The characteristics of breakdown caused by lightning on overhead power systems are well known, and the exact location can be determined when the line or substation is afterwards inspected. Thus power supply system statistics provide reliable evidence of the location and time of occurrence of lightning strokes to ground; and this type of information has accordingly been used by the author to obtain the relation between atmospherics recorder output and distance of the storm. Considerable variations are to be expected in this relationship, having regard to such facts as that the storm may cover a considerable area, and while the nearer portions may give rise to the strongest atmospherics recorded, the more remote parts of the storm may be the cause of the breakdown. A study of the results obtained over the full year 1941, however, indicates that the maximum field strength of the atmospherics recorded is approximately inversely proportional to the square root of the distance of the lightning constituting the source.

This type of knowledge has been applied with some success to give a warning of the approach of a thunderstorm to a particular area. For example, if it is desired to forecast the occurrence of storms within a radius of 60 km., a warning might be given when the atmospherics record indicates the presence of a storm within 160 km. Apparently thunderstorms seldom move faster than 50 km./hour, so that two or three hours may be expected to elapse before the outbreak of a storm; and this is in accordance with results which have been obtained in practice.

With three instruments distributed as already indicated, some storms have been recorded simultaneously at each site, and thus a location of the source has been obtained. It is frequently not possible, however, to locate in this way the widespread storms which are common in summer, as the extent of the storm is often of the same order as its distance from the recording instrument. Experience indicates that the records of a single instrument provide ample warning of the occurrence of a storm in the district; and the author appears to doubt whether it is worth while to use, for this purpose, several instruments with the necessary telephone communication facilities between the sites.

The later portions of the paper point out that the recording apparatus set up for the above application may also be used to obtain a permanent and objective record of thunderstorm activity over certain areas; and a comparison is made between such records and the statistics on the frequency of thunderstorms obtained from observers' reports. Diagrams in the paper indicate typical diurnal variations of atmospherics and the general contrast between summer and winter conditions. In the winter months, there is relatively little variation in intensity throughout the twenty-four hours; whereas in the summer, the intensity is on the whole much greater, with a pronounced maximum in the afternoon between 1500 and 1600 G.M.T. In conclusion, it is worth remarking that for storms within the range of the instrument, the rate at which lightning flashes are recorded has been found to vary from seven per hour to eighty per hour, the lower rate being associated with winter storms.

FORTHCOMING EVENTS

(Meeting marked with an asterisk is open to the public)

Saturday, March 6

GEOLOGISTS' ASSOCIATION (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Annual General Meeting. Prof. H. H. Read, F.R.S.: "Meditations on Granite" (Presidential Address).

Saturday, March 6—Sunday, March 7

INSTITUTE OF INDUSTRIAL ADMINISTRATION (at the Waldorf Hotel, Aldwych, London, W.C.2). Conference on "Training for Industrial Management".*

Saturday, March 6

10 a.m.—Management and the Nation.

11.15 a.m.—Address by His Grace the Lord Archbishop of Canterbury.

12.30 p.m.—Management and Industry.

3 p.m.—External Training for Industry.

5.30 p.m.—Internal Training in Industry.

Sunday, March 7

10 a.m.—Management and the Board Room.

11.30 a.m.—Review of Conference.

Monday, March 8

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 5 p.m.—Mijnheer Wibo Peekema: "Javanese Colonization of Sumatra".

Wednesday, March 10

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Miss M. Digby: "Agriculture To-day and To-morrow", 6: "Co-operation as a Factor in Agricultural Stability".

Friday, March 12

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5 p.m.—Sir Lawrence Bragg, F.R.S.: "Seeing Ever-smaller Worlds".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER IN CIVIL AND MECHANICAL ENGINEERING—The Principal, Huddersfield Technical College, Huddersfield (March 15).

LECTURER IN ELECTRICAL ENGINEERING in the Oxford Schools of Technology, Art and Commerce—The Chief Education Officer, 77 George Street, Oxford (March 15).

TEACHER OF MECHANICAL ENGINEERING SUBJECTS, and a TEACHER OF MATHEMATICS AND/OR SCIENCE—The Principal, Luton Technical College, Park Square, Luton, Beds. (March 15).

VETERINARY INVESTIGATION OFFICER for the Aberystwyth Advisory Province—The Principal, University College of Wales, Aberystwyth (March 20).

TEACHER OF MECHANICAL ENGINEERING—The Principal, Wolverton Technical College, Wolverton, Bucks. (March 22).

SCIENCE ASSISTANT TO ASSIST IN THE LABORATORIES—The Acting Headmistress, County School for Girls, Beaverwood Road, Perry Street, Chislehurst, Kent.

LECTURER IN CHEMISTRY—The Secretary, Woolwich Polytechnic, Woolwich, London, S.E.18.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Medical Research Council: Committee on the Care of Shipwrecked Personnel. A Guide to the Preservation of Life at Sea after Shipwreck. (M.R.C. War Memorandum No. 8.) Pp. 22. (London: H.M. Stationery Office.) 4d. net. [201

Geological Survey of Great Britain: England and Wales. Wartime Pamphlet No. 31: Some Refractory Materials in North-Eastern England. By R. G. Carruthers and W. Anderson. Pp. 19. (London: Geological Survey and Museum.) 1s. [211

Experimental Researches and Reports published by the Department of Glass Technology, The University, Sheffield. Vol. 24, 1941. Pp. iv+342. (Sheffield: The University.) 7s. 6d. [211

Department of Scientific and Industrial Research. Index to the Literature of Food Investigation. Vol. 14, No. 1, June 1942. Compiled by Agnes Elisabeth Glennie assisted by Catherine Alexander. Pp. iv+72. (London: H.M. Stationery Office.) 4s. 6d. net. [271

Other Countries

Bulletin of the American Museum of Natural History. Vol. 80, Art. 8: A Second Supplement to the American Land and Fresh-Water Isopod Crustacea. By Willard G. Van Name. Pp. 299–320. (New York: American Museum of Natural History.) [201

Annals of the New York Academy of Sciences. Vol. 43, Art. 5: The Ultracentrifuge. By D. A. MacInnes, W. J. Archibald, J. W. Beams, W. B. Bridgman, Alexandre Rothen and J. W. Williams. Pp. 173–251. (New York: New York Academy of Sciences.) [211

U.S. Department of Agriculture. Technical Bulletin No. 834: Morphology and Composition of some Soils of the Miami Family and the Miami Catena. By Irwin C. Brown and James Thorp. Pp. 55. (Washington, D.C.: Government Printing Office.) 10 cents. [211

Bulletin of the American Museum of Natural History. Vol. 80, Art. 7: Results of the Archbold Expeditions, No. 47: Review of the Vespertilionine Bats, with special attention to Genera and Species of the Archbold Collections. By G. H. H. Tate. Pp. 221–296. (New York: American Museum of Natural History.) [211

League of Nations: Economic Intelligence Service. Wartime Rationing and Consumption: (Publication 1942.II.A.2). Pp. 87. (Geneva: League of Nations: London: George Allen and Unwin, Ltd.) 3s. 6d. [221

Pushkin: a Collection of Articles and Essays on the Great Russian Poet A. S. Pushkin. Pp. 188+79 plates. (Moscow: U.S.S.R. Society for Cultural Relations with Foreign Countries.) [251

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